Scientific and Technical Analysis of Desired Future Conditions Adopted by the Lone Star Groundwater Conservation District

Submitted to:

Casey A. Bell, Administrative Law Judge

State Office of Administrative Hearings

300 W. 15th Street, Suite 504

Austin, Texas 78701

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Submitted by:

Texas Water Development Board

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Executive Summary

Representatives of groundwater conservation districts within the groundwater management areas of the state are required to collectively develop and adopt desired future conditions for their relevant groundwater resources. A desired future condition represents the desired, quantified condition of a groundwater resource (such as water levels, spring flows, or volumes) at one or more specified times in the future. After district representatives in the groundwater management area have collectively adopted a desired future condition, each district board then individually adopts the desired future condition. Once a district adopts a desired future condition, an affected person has 120 days to file a petition with the district appealing the reasonableness of the desired future condition. The district is then required, among other tasks, to forward the petition to the Texas Water Development Board (TWDB). Once received, the Board has 120 days to conduct (1) an administrative review to determine whether the desired future condition meets certain requirements in the Water Code and (2) a study containing scientific and technical analyses of the desired future condition.

District representatives of Groundwater Management Area 14 adopted desired future conditions on April 29, 2016. Following that action, the Lone Star Groundwater Conservation District (District) adopted the district-relevant desired future conditions on August 9, 2016. These desired future conditions[1] are:

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 26 feet after 61 years. [in other words, a water-level decline of 26 feet over the specified period]
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately -4 feet after 61 years. [in other words, a water-level rise of 4 feet over the specified period]
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately -4 feet after 61 years [in other words, a water-level rise of 4 feet over the specified period).
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 34 feet after 61 years.

Two petitions were filed after the District's adoption of the desired future conditions, one by Conroe and Magnolia (filed with the District on December 1, 2016) and one by Quadvest, L.P. (filed with the District on December 5, 2016). The TWDB received the Conroe and

[1] The desired future conditions are presented as adopted by the District with our clarifying remarks in brackets.

Magnolia petition from the District on December 12, 2016, and the Quadvest petition from the District on December 14, 2016.

This report documents the technical and scientific study of the desired future conditions for the Gulf Coast Aquifer System in the Lone Star Groundwater Conservation District (District). The report is intended to meet the requirement in Texas Water Code § 36.1083(e) for the TWDB to conduct a study in response to the filing of an appeal of the desired future conditions adopted by the District. Because the scope of this study is limited to the desired future conditions adopted by the District rather than the specific concerns raised in the two petitions, this document is intended to satisfy the requirements of Texas Water Code § 36.1083(e) for both petitions.

This technical and scientific study of the desired future conditions centers on if and how the "best available science" was incorporated into the desired future conditions adopted by the District. "Best available science" is defined in Texas Water Code § 36.0015(a) as "conclusions that are logically and reasonable derived using statistical or quantitative data, techniques, analyses, and studies that are publicly available to reviewing scientists and can be employed to address a specific scientific question." In applying this standard, we recognize that the best available science and data could have supported a wide range of possible drawdowns, storage volumes, or other metrics from which the District could have considered and adopted as desired future conditions. However, the scope of this evaluation is not to consider the wide range of possible desired future conditions, but only to consider the data and science used by the districts to define their desired future conditions. The following statements summarize the results of the technical and scientific study of the desired future conditions adopted by the District:

Aquifer Uses and Conditions: The district representatives used the best available science and data on aquifer uses and conditions at the time they developed and adopted the desired future conditions.

Water Supply Needs and Water Management Strategies: The district representatives used the best available science and data on water supply needs and water management strategies at the time they developed and adopted the desired future conditions.

Hydrological Conditions: The district representatives used the best available science and data on hydrological conditions at the time that they developed and adopted the desired future conditions. These data have generally been incorporated into the groundwater availability model developed by the U.S. Geological Survey and approved for planning use by the TWDB. District representatives used the model to evaluate effects of the desired future conditions.

Environmental Impacts: The district representatives used the best available data and studies of possible environmental impacts identified by district representatives at the time they developed and adopted the desired future conditions.

Subsidence: The district representatives used the best available science and data on subsidence at the time they developed and adopted the desired future conditions.

Socioeconomic Impacts: The TWDB does not know what basis must be used by groundwater conservation districts to meet the requirement of considering the socioeconomic impacts reasonably expected to occur and, therefore, cannot make any determination with regard to whether the requirement was met by the report.

Private Property Rights: The evaluation of private property rights requires a focus on political and legal issues that are beyond the scope of this technical and scientific evaluation. Therefore, the TWDB did not evaluate the impact of the adopted desired future conditions on private property rights.

Feasibility of Achieving the Desired Future Condition: The feasibility of achieving the desired future condition by the District is affected, broadly speaking, by groundwater management decisions and actions by the District and by other entities in surrounding areas, and by hydrogeologic conditions locally within the District and regionally in areas surrounding the District. The desired future conditions for individual districts are feasible because the district representatives in Groundwater Management Area 14 adopted regional desired future conditions based on regional hydrogeologic and groundwater conditions. However, it is possible that actions occurring outside the District could impact the ability of the District to achieve the desired future conditions.

Glossary[2]

Aquifer: A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Aquifer system: A body of permeable and poorly permeable material that functions regionally as a water-yielding unit; it comprises two or more permeable beds separated at least locally by confining beds that impede groundwater movement but do not greatly affect the regional hydraulic continuity of the system; includes both saturated and unsaturated parts of permeable material.

Aquifer test: A test to determine hydrologic properties of the aquifer involving the withdrawal of measured quantities of water from or addition of water to a well and the measurement of resulting changes in head in the aquifer both during and after the period of discharge or additions.

Aquitard: A geologic formation, group of formations, or part of a formation that consists of poorly permeable material that can store groundwater and transmit it slowly from one aquifer to another. See the term confining unit.

Cone of depression: A depression of the potentiometric surface in the shape of an inverted cone that develops around a well which is being pumped.

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[2] The definitions found in this glossary are from multiple sources, including:

- U.S. Geological Survey, 1989, The Federal Glossary of Selected Terms: Subsurface-Water Flow and Solute Transport: Department of Interior, U.S. Geological Survey, Office of Water Data Coordination.
- Driscoll, F., 1986, Groundwater and Wells (Second Edition): Johnson Division, St. Paul, Minnesota, 1089 p.
- Fetter, Jr., C.W., 1980, Applied Hydrogeology: Charles E. Merrill Publishing Company, 488 p.
- Heath, R.C., 1983, Basic ground-water hydrology: U.S. Geological Survey Water-Supply Paper 2220, 86 p.
- Lohman, S.W., 1972, Groundwater Hydraulics: U.S. Geological Survey Professional Paper 708, 70 p.
- Lohman, S.W. and others, 1972, Definition of Selected Ground-Water Terms – Revisions and Conceptual Refinements: U.S. Geological Survey Professional Paper 1988, 21 p.

Confined aquifer: An aquifer bounded above and below by confining units of distinctly lower permeability than that of the aquifer itself. Confined groundwater is under pressure greater than atmospheric.

Confining unit: A hydrogeologic unit of impermeable or distinctly less permeable material bounding one or more aquifers.

Drawdown: The decline in potentiometric surface at a point caused by the withdrawal of water from an aquifer.

Effective recharge: The amount of water that moves from the land surface or unsaturated zone to the water table.

Explanatory report: A report prepared by district representatives in a groundwater management area to document the process and decisions made in joint planning activities to propose and adopt desired future conditions according to Texas Water Code § 36.108.

General Head Boundary: A boundary condition in the MODFLOW groundwater numerical model code that allows the hydraulic heads at the boundary to change in a transient simulation.

Geologic formation: Rock units that have a common mode of origin, lithology, or similar properties.

Groundwater: Water in the subsurface that is in the saturated zone.

Hydraulic conductivity: The rate of flow of water through a porous medium that contains more than one fluid, such as water and air in the unsaturated zone, and which should be specified in terms of both the fluid type and content and the existing pressure.

Hydraulic gradient: A measure of the change in groundwater elevation (or head) over a given distance.

Hydraulic head: The height above a datum (such as sea level) of the column of water that can be supported by the hydraulic pressure at a given point in a ground water system. For a well, the hydraulic head is equal to the distance between the water level in the well and the datum.

Hydrogeologic unit: A rock unit (or geologic formation(s)), which by virtue of its hydraulic properties or characteristics (such as porosity, permeability, or other characteristics) has a distinct influence on the storage or movement of groundwater.

Model: A conceptual, mathematical, or physical system obeying certain specified conditions, whose behavior is used to understand the physical system to which it is analogous in some way.

MODFLOW: A computer code developed by the U.S. Geological Survey that simulates three-dimensional groundwater flow. It uses a block-centered finite difference code to compute hydraulic heads for various aquifer types.

Outcrop: The portion of a geologic formation that is exposed at the land surface.

Permeability, hydraulic conductivity: The property or capacity of a porous rock, sediment, or soil for transmitting a fluid; they are measures of the relative ease of fluid flow under unequal pressure.

Porosity: The ratio, usually expressed as a percentage, of the total volume of voids of a given porous medium to the total volume of the porous medium.

Potentiometric surface: The potentiometric surface is a surface which represents the static head and is the level to which water will rise in tightly cased wells.

Storage coefficient, storativity: The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

Specific yield: The ratio of the volume of water which the porous medium after being saturated, will yield by gravity to the volume of the porous medium.

Spring: A discrete place where groundwater flows naturally from the ground onto the land surface or into a body of surface water.

Subsidence: The gradual settling of the land surface owing to subsurface movement of earth materials (for example, the compaction of sediments in an aquifer).

Total estimated recoverable storage: The estimated amount of groundwater within an aquifer that accounts for recovery scenarios that ranges between 25 percent and 75 percent of the total porosity-adjusted aquifer volume.

Transmissivity: The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient.

Unconfined aquifer: An aquifer where water in the aquifer is exposed to the atmosphere through openings in the overlying materials. Unconfined groundwater is water in an aquifer that has a water table.

Water table: The upper surface of a zone of saturation except where that surface is formed by a confining unit.

1.0 Introduction

This report documents the technical and scientific study of the desired future conditions for the Gulf Coast Aquifer System in the Lone Star Groundwater Conservation District (District). The report fulfills the requirement of Texas Water Code § 36.1083(e) for the Texas Water Development Board (TWDB) to conduct a study in response to the filing of an appeal of the desired future condition adopted by the District. The District is located in Groundwater Management Area 14, and its boundaries coincide with those of Montgomery County (Figure 1-1).

The District adopted applicable desired future conditions on August 6, 2016. These desired future conditions are:

- From estimated year 2009 conditions, the average drawdown of the Chicot Aquifer should not exceed approximately 26 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Evangeline Aquifer should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Burkeville confining unit should not exceed approximately -4 feet after 61 years.
- From estimated year 2009 conditions, the average drawdown of the Jasper Aquifer should not exceed approximately 34 feet after 61 years.

The cities of Conroe and Magnolia (together) and Quadvest, L.P. have each filed petitions with the District appealing the reasonableness of the desired future conditions. Because the scope of this study is limited to the desired future conditions rather than the specific elements of the two petitions, this document is intended to satisfy the requirements of Texas Water Code § 36.1083(e) for both petitions.

This technical and scientific study of the desired future conditions has centered on how the "best available science" was incorporated into the desired future conditions adopted by the District. "Best available science" is defined in Texas Water Code § 36.0015 as "conclusions that are logically and reasonable derived using statistical or quantitative data, techniques, analyses, and studies that area publicly available to reviewing scientists and can be employed to address a specific scientific question." This document is organized to be responsive to the portions of Texas Water Code § 36.1083(e) required for this study. The following chart illustrates where this document addresses these requirements.

Texas Water Code § 36.1083(e) Requirement		Location in the document where this requirement is addressed
▪ An administrative review to determine whether the desired future condition establish by the district meets the criteria in Section 36.108(d);		Section 2
▪ A study containing the scientific and technical analysis of the desired future conditions, including consideration of:		(see below for specific references)
	the hydrogeology of the aquifer	Section 3, Section 6.3
	the explanatory report provided to the development board under Section 36.108(d-3);	Section 6, and throughout the document
	the factors described under Section 36.108(d);	Section 6
	groundwater availability models	Section 7
	any relevant published studies;	Section 6, and throughout the document
	estimates of total recoverable storage capacity	Section 6.3
	average annual amounts of recharge, inflows, and discharge of groundwater	Section 6
	information provided in the petition or available to the development board	Section 6.9

Study Conditions, Assumptions, and Limitations

The TWDB prepared this report according to the requirements in Texas Water Code § 36.1083(e) , 31 Texas Administrative Code § 356.41, and the guidance published by the TWDB on the agency website: http://www.twdb.texas.gov/groundwater/docs/DFC_Petition_Guidance.pdf

The purpose of the scientific and technical analysis of the desired future conditions is to ensure that the explanatory report incorporated and applied the best available science and data to support the District's decision to adopt the desired future conditions. TWDB staff has not recreated the investigations supporting the explanatory report, but has analyzed and verified the materials and conclusions presented in the explanatory report. The scope of the scientific and technical analysis is limited to the geographic area, aquifers, and groundwater conditions specific to the desired future conditions.

The TWDB Groundwater Division staff is primarily responsible for conducting this scientific and technical evaluation of the desired future conditions. All work performed for the scientific and technical analysis has been performed by or under the direct supervision of a Texas Professional Geoscientist and reviewed and approved by the Director of the Groundwater Division, the Deputy Executive Administrator of Water Science and Conservation, and the Executive Administrator.

2.0 Administrative Completeness Review

Texas Water Code § 36.1083(e) requires that the TWDB conduct an administrative review to determine whether the desired future conditions established by the District meets the criteria in § 36.108(d). This review was conducted by the TWDB after receiving the explanatory report and supporting documentation from Ms. Kathy Turner Jones, General Manager of the Lone Star Groundwater Conservation District, on May 6, 2016. The submission included (1) the desired future conditions explanatory report and the adopted desired future conditions for the relevant aquifers; (2) the resolution signed by district representatives voting on the adoption of the desired future conditions; (3) the postings, minutes, and voting record for the public meeting in which the desired future conditions were adopted; (4) contact information for the designated representative of the groundwater management area; and (5) the groundwater availability model files used in developing the adopted desired future conditions. TWDB's Executive Administrator notified Ms. Kathy Turner Jones that the submitted materials were administratively complete in accordance with 31 Texas Administrative Code § 356.33 on July 12, 2016. This notification is provided in Appendix A.

As part of the effort to prepare this scientific and technical evaluation of the desired future conditions, the TWDB has conducted an administrative review of the desired future conditions consistent with the requirements and scope of Texas Water Code § 36.1083(e) and confirms that the desired future conditions established by the District meet the criteria in § 36.108(d).

3.0 District Hydrogeology

The hydrogeology of Montgomery County has been documented in numerous technical reports, published articles, and presentations. The following paragraphs summarize the aquifers and groundwater conditions in the District based primarily on information in several technical reports (especially Popkin, 1971, and Kasmarek, 2012).

Hydrogeologic Units and Aquifers

The geologic units that contain fresh to slightly saline water in Montgomery County consist of alternating beds of sand and clay with minor amounts of gravel. The U.S. Geological Survey (Kasmarek, 2012) considers "sand" to be coarse-grained sand and gravel and "clay" to be fine-grained sediment including clay and silt. The principal geologic formations include (from oldest to youngest) the Catahoula Sandstone (which is exposed at the land surface north of the county), the Oakville Sandstone, the Fleming Formation (and Lagarto Clay), the Goliad Sand, the Willis Sand, the Bentley Formation, Montgomery Formation, and the Beaumont Clay. Alluvium occurs in the major stream and river valleys. Most of these geologic units are visible at the surface and dip toward the Gulf of Mexico at an angle greater than the slope of the land surface. Most of these formations dip at rates ranging from 40 to 85 feet per mile. These geologic formations are grouped together to form the four main hydrogeologic units (aquifers and confining unit) in Montgomery County based on their common hydraulic properties and similar groundwater-bearing characteristics. Figure 3-1 relates the geologic formations and the corresponding aquifers in the northern part of the Gulf Coast region.

The Gulf Coast Aquifer System includes the Chicot, Evangeline, and Jasper aquifers and the Burkeville confining unit. The Chicot Aquifer consists of the alluvium, Beaumont Clay, Montgomery Formation, Bentley Formation, and Willis Sand. The Evangeline Aquifer includes the Goliad Sand and upper part of the Fleming Formation. The Burkeville confining unit consists entirely of the Fleming Formation. The Jasper Aquifer consists of the lower portion of the Fleming Formation and the upper portion of the Catahoula Sandstone. Figure 3-2 illustrates where these aquifers occur at the land surface in the region. The aquifers in Montgomery County consist of semi-consolidated or unconsolidated sand interbedded with clay. The Burkeville confining unit consists of clay that in some places includes sand. Figure 3-3 is a cross-section diagram that illustrates the geologic structure and the relative thickness of the aquifers that comprise the Gulf Coast Aquifer System.

Groundwater Flow

Groundwater in the Gulf Coast Aquifer System in Montgomery County occurs under both unconfined (water table) and confined (artesian) conditions. A well screened in an unconfined aquifer will have a water level equal to the water level in the aquifer.

Groundwater in outcrop areas of aquifers is usually unconfined. A confined aquifer is bounded by less permeable geologic units, or aquitards, at the top and bottom, and the aquifer is under hydraulic pressure above the ambient atmospheric pressure. The water level at a well screened in a confined aquifer will be above the top of the aquifer.

Groundwater in the Gulf Coast Aquifer System flows from areas with high groundwater elevations to areas of lower groundwater elevations. Regionally speaking, groundwater in the District generally flows toward the southeast toward the Gulf of Mexico. However, since groundwater pumping began, groundwater flow directions have been locally re-directed toward pumping wells. Figure 3-4 is a schematic cross-section that illustrates the relationships of the aquifers and the general movement of groundwater in a downdip (toward the Gulf of Mexico) direction. When groundwater elevations are contoured, it is apparent that there are local depressions in the potentiometric surface, which, here, is a composite of groundwater elevations measured in both the confined and unconfined parts of an aquifer. Figure 3-5 is a map of groundwater elevations in the Evangeline Aquifer, a significant source of groundwater for public supply and other uses in the region. The closed contour lines in southern Montgomery County and in Harris County to the south illustrate the situation where individual cones of depression have expanded and in some cases merged, forming sub-regional depressions in the groundwater elevation surface.

Recharge

Recharge is the process whereby water enters the water table from infiltration through soil in the outcrop or by seepage from streams or other surface water. The amount of recharge that an aquifer receives is controlled by many factors such as rainfall amounts, soil type, vegetation, land use, topography, and the ability of the aquifer material to transmit water.

Only a fraction of the total recharge entering the aquifer in the outcrop travels to the confined section of the aquifer and becomes part of the regional aquifer flow system. This is sometimes referred to as effective recharge. Most of the total recharge entering the Gulf Coast Aquifer System is discharged locally to streams and valleys in the aquifer outcrop (Kasmarek and Robinson, 2004). The recharge that is discharged in the shallow part of the aquifer is sometimes referred to as rejected recharge. Although this water is “rejected” from a water development standpoint, it contributes to springs and baseflow to overlying streams and rivers.

Recharge estimates from a recent study for the Gulf Coast Aquifer System in Montgomery County range from about half an inch to three inches per year (Scanlon and others, 2012). Oden and Delin (2013) reviewed the available information for the northern Gulf Coast Aquifer System and concluded that recharge estimates range from 0.2 to 7.2 inches per year for the Chicot Aquifer, from less than 0.1 to 2.8 inches per year for the Evangeline Aquifer, and from less than 0.1 to 0.5 inches per year for the Jasper Aquifer.

4.0 Developing Desired Future Conditions

The foundational principle of groundwater management in Texas is based on the English common law rule that landowners have the right to capture or remove all of the water that can be captured from beneath their land. This is known as the "rule of capture." In 1949, the legislature authorized the creation of groundwater conservation districts to manage groundwater locally. Today groundwater is still governed by the rule of capture, unless modified under the authority of a groundwater conservation district or a special district created by the legislature. Groundwater conservation districts are the state's preferred method of groundwater management in order to protect property rights, balance the conservation and development of groundwater to meet the needs of the state, and use the best available science in the conservation and development of groundwater through rules developed, adopted, and promulgated by a district (Texas Water Code § 36.0015).

Since the original legislation creating groundwater districts, the legislature has made several changes to the way groundwater is managed in the state while still providing for local management. In 2005, the 79th Texas Legislature passed House Bill 1763, which required groundwater conservation districts to meet regularly and to define the desired future conditions of the groundwater resources within designated groundwater management areas. A desired future condition is a quantitative description, adopted in accordance with Texas Water Code § 36.108, of the desired condition of the groundwater resources in a management area at one or more specified future times. A groundwater management area is defined as an area suitable for the management of groundwater resources. Sixteen groundwater management areas, whose boundaries are generally based on the outline of the major aquifers, have been established in the state.

Figure 4-1 illustrates the major activities that are performed for joint planning by the district representatives in a groundwater management area. The joint planning process is important because it defines the amount of groundwater available to be considered for pumping by districts in its groundwater management plan and rules and is used by regional water planning groups for water availability in the state's water plan. Groundwater conservation districts are charged by statute with achieving the desired future conditions.

The Desired Future Conditions Process

As part of joint planning, representatives from the different groundwater conservation districts within a groundwater management area must propose and adopt desired future conditions for relevant aquifers, defined as major or minor aquifers, in their respective areas. Then, individual groundwater conservation districts adopt those desired future conditions applicable to the district. Desired future conditions may be expressed a number of ways, including water levels, springflows, subsidence, and storage volumes.

District representatives have 60 days after desired future conditions are adopted to provide the TWDB's Executive Administrator with a copy of an explanatory report, proof that notices were posted for the joint planning meetings, and a copy of the desired future conditions resolution. TWDB rules (31 Texas Administrative Code § 356.32) also require district representatives to submit any groundwater availability model files or aquifer assessments that were used in developing the adopted desired future conditions. The explanatory report must:

- identify each desired future condition and provide the policy and technical justifications for each desired future condition;
- document that the districts considered the required nine factors listed in Texas Water Code § 36.108(d) and discuss how the adopted desired future conditions impact each factor;
- list other desired future condition options considered, if any, and the reasons why those options were not adopted;
- discuss how the desired future conditions provide a balance between the highest practicable level of groundwater production and the conservation, preservation, protection, recharging, and prevention of waste of groundwater and control of subsidence; and
- discuss reasons why recommendations made by advisory committees and relevant public comments received by the districts were or were not incorporated into the desired future conditions.

Modeled Available Groundwater

After TWDB's Executive Administrator determines that the explanatory report and other materials are administratively complete, the TWDB calculates the modeled available groundwater. Modeled available groundwater is the estimated groundwater pumping rate that will achieve an adopted desired future condition in an aquifer. To determine the modeled available groundwater, the TWDB uses groundwater availability models, if available, to simulate the effects of groundwater pumping from wells on the aquifer system. Districts then use the modeled available groundwater values as one factor in making decisions on permitting and managing groundwater withdrawals.

Total Estimated Recoverable Storage

Texas Water Code § 36.108(d)(3) requires the TWDB to provide the estimated total recoverable storage for each relevant aquifer in the management area to districts in each management area. The total estimated recoverable storage is defined by the TWDB as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 percent and 75 percent of the total porosity-adjusted aquifer volume. In other words, the TWDB assumes that 25 to 75 percent of groundwater held within an aquifer can be drained without considering the physical and economic possibility of draining the aquifer. Total estimated recoverable storage is based on the drainable volume of the aquifer, typically from layer/structure information used in groundwater availability models, which have been publically reviewed by regional stakeholders and accepted by the Executive Administrator of the Texas Water Development Board. It accounts for the volume of groundwater only within official aquifer boundaries.

Total estimated recoverable storage is one factor that districts in a groundwater management area should consider before voting on their desired future conditions (see Texas Water Code §36.108(d)). These storage values do not necessarily mean that the groundwater volume is available for production since it is through the local management of the groundwater resource by districts in accordance with the desired future condition of the aquifer that sets policy priorities and guides permitting and production of groundwater.

The total estimated recoverable storage and modeled available groundwater are completely different concepts and values. Storage is a groundwater volume expressed as a volume in acre-feet. It is typically a very large value, as most of the major aquifers in Texas cover thousands of square miles and may be hundreds of feet thick. Total estimated recoverable storage values may include a mixture of water quality types, including fresh, brackish, and saline groundwater, because the available data and the existing groundwater availability models do not permit the differentiation between different water quality types. The total estimated recoverable storage does not consider the technical practicability, economics, or environmental consequences of pumping that volume of groundwater from an aquifer. Specifically, the total estimated recoverable storage does not consider any potential effects of pumping, such as land subsidence that could be triggered or accelerated, dewatering of existing wells due to water levels dropping below pumps, degradation of water quality because pumping induces movement of brackish or saline aquifer into formerly fresh water areas, or possible effects on springflow or river flow that is connected to groundwater. In contrast, modeled available groundwater is a "pumping rate," expressed as a volume over time in acre-feet per year.

The calculation of total storage is different between unconfined and confined aquifers. For an unconfined aquifer, the total storage is equal to the volume of groundwater removed by drainage that makes the water level fall to the base of the aquifer. For a confined aquifer, the total storage contains two parts. The first part is the groundwater released from the aquifer by the reduction of artesian pressure in the aquifer, causing the water level to lower from above the top of the aquifer to the top of the aquifer. The aquifer is still fully saturated at this point. The second part, like an unconfined aquifer, is equal to the volume of groundwater removed by drainage that makes the water level fall to the base of the aquifer. Given the same aquifer area and water level drop, the amount of water released in the second part is much greater than the first part (Figure 4-2).

5.0 Desired Future Conditions and Modeled Available Groundwater for the Lone Star Groundwater Conservation District

In 2010, the district representatives in Groundwater Management Area 14 adopted desired future conditions for the first time. This was the first cycle of joint planning in which districts identified and adopted desired future conditions for their relevant aquifers. The District adopted desired future conditions for three aquifers (and one confining unit): the Jasper Aquifer, the Burkeville confining unit, the Evangeline Aquifer, and the Chicot Aquifer (Table 5-1). The desired future conditions were expressed as a two-stage policy (2008 and 2016) to represent different management goals as the District's management policies were implemented by 2016. No appeal was made concerning the reasonableness of the desired future conditions adopted in 2010.

The second cycle of joint planning for districts in Groundwater Management Area 14 was underway by 2013. In 2014, district representatives increased the frequency of joint planning meetings and voted to propose desired future conditions in mid-2015. The TWDB provided the total estimated recoverable storage values for the Gulf Coast Aquifer System (TWDB, 2014) to districts in Groundwater Management Area 14 on June 9, 2014. After reviewing the total estimated recoverable storage values, district representatives requested that the TWDB distinguish between groundwater in "unconfined" storage versus groundwater in "confined" storage. The TWDB provided the results of that analysis to the districts on August 19, 2015. The following timeline illustrates the major activities and decisions made by district representatives in Groundwater Management Area 14 and the District:

- June 9, 2014: TWDB provided district representatives with values of the total estimated recoverable storage.
- June 24, 2015: District representatives proposed desired future conditions.
- September 17, 2015: The District held a public meeting to received public comment on the proposed desired future conditions.
- October 5, 2015: Last day that public comments on the proposed desired future conditions were accepted by the District.
- October 12, 2015: The District held a work session to discuss "Draft Summary Report for Comments Received During 90-Day Comment Period for Proposed Statements of Desired Future Conditions."
- October 13, 2015: The District voted to accept the Summary Report with comments and forward to the district representatives with no changes to the proposed desired future conditions.
- April 29, 2016: District representatives reconvened and adopted final desired future conditions.

- May 6, 2016: TWDB received the desired future conditions statements and the explanatory report from the district representatives.
- July 12, 2016: TWDB's Executive Administrator approved the desired future conditions statement submittal as administratively complete.
- August 9, 2016: The District adopted desired future conditions for its district.
- December 1, 2016: City of Conroe and City of Magnolia filed an appeal against the desired future conditions adopted by the District. The TWDB received a copy of the petition on December 12, 2016.
- December 5, 2016: Quadvest, L.P. filed an appeal against the desired future conditions adopted by the District. The TWDB received a copy of the petition on December 14, 2016.
- December 15, 2016: TWDB provided estimates of modeled available groundwater to the districts of Groundwater Management Area 14.

Table 5-2 shows the desired future conditions adopted by the District. Table 5-3 summarizes the differences between the 2010 and the 2016 desired future conditions adopted by the District (comparing year 2060).

6.0 Scientific and Technical Analysis of Desired Future Conditions—Factor Evaluation

This section addresses each of the criteria outlined in Texas Water Code § 36.108 that districts in a groundwater management area must consider as part of the joint planning efforts that result in proposed and adopted desired future conditions. These criteria include

a) aquifer uses or conditions within the management area, including conditions that differ substantially from one geographic area to another;
b) the water supply needs and water management strategies included in the state water plan;
c) hydrological conditions, including for each aquifer in the management area the total estimated recoverable storage as provided by the Executive Administrator, and the average annual recharge, inflows, and discharge;
d) other environmental impacts, including impacts on spring flow and other interactions between groundwater and surface water;
e) the impact on subsidence;
f) socioeconomic impacts reasonably expected to occur;
g) the impact on the interests and rights in private property, including ownership and the rights of management area landowners and their lessees and assigns in groundwater as recognized under Texas Water Code § 36.002;
h) the feasibility of achieving the desired future condition; and
i) any other information relevant to the specific desired future conditions.

6.1 Aquifer Uses and Conditions

Summary: *The district representatives used the best available science and data on aquifer uses and conditions at the time they developed and adopted the desired future conditions.*

Aquifer Uses

Groundwater use in Montgomery County is dominated by pumping for municipal water supplies, which account for about 87 percent of the groundwater pumping in the District (Table 6-1). Municipal pumping in the District has been accomplished through the development of local, non-regional infrastructure. The District's 2015 Annual Report shows the breakdown of permitted pumping by water use category (Table 6-1). Figure 6-1 shows the locations of public supply wells in Montgomery County, as reported in TWDB's groundwater database, and municipal utility district boundaries from the Texas Commission on Environmental Quality (TCEQ) database of public water system wells and surface water intakes (TCEQ, 2017).

The district representatives obtained the groundwater use data in its explanatory report from TWDB's Water Use Survey and Groundwater Database and through other sources of estimates such as the records of the District. As noted in the explanatory report, data were summarized from the years 2001 through 2011 to illustrate average conditions (p. 40). Data in the explanatory report for Montgomery County pumpage do not match current values in the TWDB database (Groundwater Management Area 14, 2016; TWDB, 2017). In most cases, the difference is minor, but differences do exist for 2004, 2005, and 2011, as shown in Table 6-2. Both sets of numbers indicate rapid expansion of groundwater production in Montgomery County from about 2007 to 2011. TWDB data for 2012 through 2014 indicate declining pumping rates during that period.

Historical water use data have not been consistently assigned to the individual aquifers that make up the Gulf Coast Aquifer System (the Chicot Aquifer, Evangeline Aquifer, Burkeville Confining Unit, and Jasper Aquifer). It is common in the Gulf Coast Aquifer System, and in other large stratified aquifers, for large capacity water wells to be constructed with multiple screens in different aquifer units or be designed with very long screens that extend over and intercept multiple aquifer units. Therefore, pumping estimates are reported at the broader "Gulf Coast Aquifer System" level (Table 6-3). The "Other/Unknown Aquifer" groundwater in Table 6-3 is likely from either the Gulf Coast Aquifer System or near-surface alluvial aquifers, or a combination of both. All of the other aquifers for which groundwater pumped is recorded in the TWDB's Water Use Survey and Groundwater Database individually represent less than one percent of the total groundwater pumped in Groundwater Management Area 14.

The district representatives used the most recently available data on the locations and volumes of groundwater produced in the District. Locations and volumes pumped from individual wells and/or permit holders are not discussed in the explanatory report, but the pumping distribution for the current approved groundwater availability model is largely derived from the pumping files for the previous groundwater availability model (Kasmarek and others, 2005). As part of that model development, U.S. Geological Survey modelers examined TWDB regional water planning data, the Texas Commission on Environmental Quality Public Water System database, the TWDB state well database, and the U.S. Environmental Protection Agency Envirofacts database for information on locations and volumes of groundwater production. The U.S. Geological Survey assigned groundwater production to specific aquifers where that information was available or distributed to all aquifers intersecting the well where no specific data were found (Kasmarek and others, 2005). Descriptions of groundwater use included in the supporting materials in Appendix G of the explanatory report largely re-iterate the TWDB water use data with no additional detail on location, purpose, or ownership of major groundwater production facilities in Groundwater Management Area 14.

Aquifer Conditions

District representatives documented general aquifer conditions in their explanatory report. One factor relevant to the TWDB's technical and scientific evaluation of the desired future conditions includes pumping-induced cones of depression in the potentiometric surfaces of the Chicot, Evangeline, and Jasper aquifers. The cones of depression develop around the locations of pumping within each formation and extend from southern Montgomery County, primarily in the southern Conroe and The Woodlands areas, into several neighboring counties, particularly Harris County (Figures 6-2 through 6-4).

In the Harris-Galveston area, numerous studies have linked oil and gas extraction and groundwater pumping in the Gulf Coast Aquifer System to regional land-surface subsidence (Winslow and Dovel, 1954; Gabrysch, 1970; Galloway and others, 1999; Kasmarek and others, 2015; Ramage, 2016). District representatives identified subsidence as the pre-eminent management concern for the region considering the high potential for damage to property and infrastructure because of ground movement and flooding directly related to subsidence. District representatives identified measurement of artesian pressures in the aquifer (as expressed in static water levels below land surface or above mean sea level in a well) as a suitable proxy for potential subsidence. In addition, direct measurements of subsidence in the Harris-Galveston and Fort Bend subsidence districts also serve as metrics for long-range planning purposes in Groundwater Management Area 14.

While aquifers and aquifer properties are continuous across political boundaries, the explanatory report notes that historical pumpage, along with the hydrogeologic characteristics of the aquifers, has resulted in patterns of potentiometric surface elevations that vary from county to county across the groundwater management area (Groundwater Management Area 14, 2016). Groundwater pumpage itself has historically varied as a function of demographics, land use planning, and public investments, which in part reflect local government policies.

6.2 Water Supply Needs and Water Management Strategies

Summary: *The district representatives used the best available science and data on water supply needs and water management strategies at the time they developed and adopted the desired future conditions.*

District representatives documented the continued population growth in the area, water supply needs, and recommended water management strategies included in the 2011 Region H Water Plan and the 2012 State Water Plan.

Data presented in the explanatory report was drawn from county-level data in the 2012 State Water Plan, as shown on Figure 6-5. TWDB staff checked the values in the explanatory report against the values of water supplies and water strategies in the 2012 State Water Plan. The changes in water supplies and water management strategies reflect increasing reliance on surface water and other non-groundwater sources over time to meet future needs, consistent with the desired future conditions adopted by the District.

6.3 Hydrological Conditions

Summary: *The district representatives used the best available science and data on hydrological conditions at the time that they developed and adopted the desired future conditions. These data have generally been incorporated into the groundwater availability model developed by the U.S. Geological Survey and approved for planning use by the TWDB. District representatives used the model to evaluate effects of the desired future conditions.*

District representatives used contour maps of the potentiometric surface of the aquifers making up the Gulf Coast Aquifer System as the primary indicator of hydrogeological conditions. Maps (Figure 6-2 [Chicot Aquifer], Figure 6-3 [Evangeline Aquifer], and Figure 6-4 [Jasper Aquifer]) presented in the Groundwater Management Area 14 joint planning meetings, showing drawdown contours as of 2009, are included in the explanatory report.

The U.S. Geological Survey prepares annual maps of the groundwater potentiometric surface and land surface subsidence in the Houston-Galveston (including Montgomery County) area. Maps of the 2015 potentiometric surface for the Chicot, Evangeline, and Jasper aquifers are included for reference as Figures 6-6, 6-7, and 6-8 (from Kasmarek and others, 2015). Based on the multi-year series of potentiometric surface maps, drawdown in Montgomery County increased between 2009 and 2015, while water levels gradually increased in Harris and Fort Bend counties. Additional potentiometric surface maps, showing water-level changes over specified intervals for each aquifer, are also available in the U.S. Geological Survey report (Kasmarek and others, 2015).

The following portion of this review addresses other relevant aspects of the Gulf Coast Aquifer System hydrological conditions, including the total estimated recoverable storage, groundwater recharge, other inflows, and aquifer discharge data.

Total Estimated Recoverable Storage

Figure 6-9 illustrates the ranges of the total estimated recoverable storage for the counties in Groundwater Management Area 14. District representatives also requested data from the TWDB on the breakdown of confined versus unconfined components of groundwater in storage. Table 6-4 shows the breakdown of the total estimated recoverable storage into confined and unconfined components in the District, as provided by the TWDB and included in the explanatory report. After reviewing the total estimated recoverable storage values, Groundwater Management Area 14 district representatives noted that the Gulf

Coast Aquifer System in Groundwater Management Area 14 contains 2,776,000,000 acre-feet in total storage, with 10,952,354 acre-feet in confined storage, which is equivalent to 0.39 percent of the total storage volume.

At the request of Kathy Turner Jones, chair of the Groundwater Management Area 14 district representatives, the TWDB provided clarification on the features of the total estimated recoverable storage values provided to the districts. The July 15, 2015, letter from the TWDB to Ms. Jones, states:

> "The Texas Water Development Board is required by law to provide the total estimated recoverable storage for each aquifer in each groundwater management area. Texas Administrative Code § 356.10 defines the total estimated recoverable storage as the estimated amount of groundwater within an aquifer that accounts for recovery scenarios that range between 25 percent and 75 percent of the porosity-adjusted aquifer volume.
>
> The following points are essential for groundwater management areas to recognize when they receive the total estimated recoverable storage values and consider them in their joint planning efforts:
>
> - Total estimated recoverable storage is one factor (along with a number of other required factors) that districts in a groundwater management area should consider before voting on their desired future conditions (see Texas Water Code § 36.108(d)).
> - Total estimated recoverable storage is based on the drainable volume of the aquifer, typically from layer/structure information used in groundwater availability models, which have been publicly reviewed by regional stakeholders and accepted by the Executive Administrator of the Texas Water Development Board. It accounts for the volume of groundwater only within official aquifer boundaries (see TWDB Report No. 380 – Aquifers of Texas).
> - The total estimated recoverable storage does not consider whether or not the quality of the groundwater is fresh, brackish, or saline.
> - The total estimated recoverable storage does not consider the technical practicability, economics, or environmental consequences of pumping that volume of groundwater from an aquifer. Specifically, the total estimated recoverable storage does not consider any potential effects of pumping, such as land subsidence that could be triggered or accelerated, dewatering of existing wells due to water levels dropping below pumps, degradation of water quality because pumping induces movement of brackish or saline aquifer into formerly fresh water areas, or possible effects on springflow or river flow that is connected to groundwater.

- The total estimated recoverable storage value is almost always much higher than the modeled available groundwater value, which is an estimated annual pumping rate that would achieve a desired future condition of the aquifer.

In summary, the total estimated recoverable storage is one of several factors that districts in a groundwater management area must consider by law when identifying possible desired future conditions. It is important to remember that these storage values do not necessarily mean that groundwater volume is available for production since it is through the local management of the groundwater resource by districts in accordance with the desired future condition of the aquifer that sets policy priorities and guides permitting and production of groundwater."

Recharge

District representatives received information about groundwater recharge as part of the overall water budget for each relevant aquifer (see Appendix L of the explanatory report). Recharge and other inflow volumes were quantified using the groundwater availability model for the northern portion of the Gulf Coast Aquifer System. However, the model does not explicitly incorporate recharge processes since the model uses a general head boundary in the outcrop areas to model aquifer behavior. The general head boundary condition allows head-dependent flow between the water table and deeper layers in the model. A key assumption is that the water table maintains a constant level. Kasmarek and Robinson (2004) document hydrographs for two wells, one in the Chicot outcrop in Montgomery County, and one in the Evangeline outcrop in Liberty County, that exhibit relatively constant water levels over the period from 1930 to 1990 (Chicot) and 1947 to 1999 (Evangeline) as evidence that the Gulf Coast Aquifer conforms to the constant water table assumption (Figure 6-10). However, future development and groundwater pumping in the aquifer outcrop areas may result in more widely varying water levels than have been documented in the past.

The available predictive model runs use future pumping scenarios based on the current and historical distribution of groundwater production wells, as described in Section 6.1. While this adequately represents current conditions, it may not conform to future groundwater use patterns and their potential impact on groundwater recharge.

Inflows, outflows, and discharge

District representatives discussed output from the groundwater availability modeling runs containing all aspects of the water budget for the aquifers making up the Gulf Coast Aquifer System, including recharge, lateral inflow and outflow, leakage between aquifer units, pumping, and discharge. Appendix L of the explanatory report includes the water budget data for each county in Groundwater Management Area 14, calculated as average flows for the period from 2000 to 2009. Modeled water budget information presented by Mullican (2015) for the District (Montgomery County) is reported in Appendix L of the explanatory report and is shown on Table 6-5.

Inflow to the Gulf Coast Aquifer System in Montgomery County is mostly through the Chicot outcrop, which averaged 31,407 acre-feet per year for 2000 through 2009. Much smaller quantities of recharge occur in the Evangeline and Jasper aquifers. Because of the way in which the groundwater availability model was structured, using a general head boundary in the aquifer outcrop areas, the model does not distinguish between recharge and stream losses. It is important to note that, as a result of the algebraic peculiarities of computer model code, the storage term in the "Inflow" section of Table 6-5 actually represents a loss of storage, as reflected in the bottom line of the table, which shows the average net storage change for each aquifer. A graphical representation of the modeled water budget for Montgomery County is included as Figure 6-11 (Groundwater Management Area 14, 2016, Appendix J).

Model results indicate that an average groundwater flow of more than 30,000 acre-feet per year moves from the Chicot to the Evangeline aquifer in the District, but that lateral flows are more important than vertical movement between the aquifers. The largest lateral flows are outflow from the District to Harris County through the Chicot and Evangeline aquifers, which average 33,337 and 17,670 acre-feet per year, respectively. Modeled lateral inflows to the Chicot, Evangeline, and Jasper aquifers from Grimes, Harris, Liberty, San Jacinto, Waller, and Walker counties total 36,955 acre-feet per year; lateral flow from Walker County into the Jasper Aquifer is the largest contributor at 10,845 acre-feet per year.

Overall, aquifer discharges exceed inflows, resulting in an average net change in storage of 31,048 acre-feet per year for the period from 2000 to 2009. Pumping from wells is the main form of discharge from the Gulf Coast Aquifer System, with a 2000 to 2009 average volume of 57,820 acre-feet per year. As noted elsewhere, the volume of discharge through pumping increased between 2009 and 2015. Figure 6-12 illustrates the pumping rates implemented in the groundwater availability model run used to support the desired future conditions for the District.

6.4 Other Environmental Impacts

Summary: *The district representatives used the best available data and studies of possible environmental impacts identified by district representatives at the time they developed and adopted the desired future conditions.*

In general, the explanatory report cites literature sources that find limited connection between groundwater and surface-water resources in Groundwater Management Area 14 but does not provide quantitative data on the extent of interactions that may occur. A

TWDB-sponsored study of groundwater-surface water interactions (Parsons Engineering, 1999) noted that "the lithology of the Willis Sand and Oakville Formation underlying Lake Conroe indicates that the permeability is moderate to high and interaction between the aquifer and the reservoir would be likely." The Parsons report discusses the potential for area-wide recharge over the aquifer outcrop, the likelihood of rejected recharge or shallow circulation and discharge back to the river system, and the effects of groundwater pumping, but concludes that "the magnitude of the interaction cannot be determined with the current literature review." Figure 6-13 summarizes the discussion presented in the Parsons report.

A compilation of U.S. Geological Survey data on groundwater-surface water interactions lists 13 gaging sites in Montgomery County where stream flow gain or loss to the Gulf Coast Aquifer was estimated (Slade and others, 2002). Measured values at these sites ranged from a loss of 1.5 cubic feet per second to a gain of 4.17 cubic feet per second with an average gain of 1.1 cubic feet per second for the measured stream reaches.

Pumping from the Gulf Coast Aquifer System is likely to affect groundwater–surface interactions. As noted in the Parsons report, if pumping reduces groundwater levels in the unconfined outcrop areas, then discharges from groundwater to local streams would be reduced and could, in some conditions, be locally reversed so that surface water recharges groundwater. Additional modeling, explicitly incorporating the appropriate MODFLOW packages, would be needed to quantitatively evaluate the magnitude of any potential effects.

6.5 Subsidence

Summary: *The district representatives used the best available science and data on subsidence at the time they developed and adopted the desired future conditions.*

District representatives discussed available scientific studies and literature related to documented and projected land subsidence in Groundwater Management Area 14. The results of the discussions are summarized in Section 5.5 of the explanatory report.

Subsidence can occur in Texas and many other regions when the water pressure in an aquifer is reduced in response to groundwater pumping. The hydrostatic pressure of the confined aquifer system in effect acts to support the aquifer matrix against the weight of the overburden materials. As the hydrostatic pressure is reduced, the grains of the aquifer and surrounding sediments are pressed more closely together, shrinking the overall volume of the aquifer. This effect is most pronounced in sections of the formation with a high clay content because clay mineral particles typically have a flat, plate-like geometry that leads to large changes in volume as the particles are compressed and moved into alignment with one another (Figure 6-14).

Subsidence is measured using GPS receivers mounted on well heads, which reflect the total ground surface elevation change at that location, and with borehole extensometers, which measure relative elevation changes between an anchor point at the base of the borehole and the ground surface. Compaction in individual aquifer units can be assessed by placing several extensometers completed at different depths in close proximity to each other.

U.S. Geological Survey maps indicate that one to two feet of subsidence occurred between 1906 and 2000 in parts of southeastern Montgomery County. Yu and others (2014) show measured subsidence rates close to 0.6 inches per year for 2006 through 2012 just south of Conroe, with a maximum rate of about 1 inch per year at the Montgomery-Harris county line, just north of Spring (Figure 6-15). Yu and others (2014) conclude most subsidence is occurring in the Chicot and Evangeline aquifers and that deep-seated subsidence is not likely occurring in the Houston-Galveston area. Recent subsidence (1993–2012) in the Houston-Galveston area is dominated by the compaction of sediments within 2,000 feet below the land surface. Depending on the location of specific sites, the compaction occurred within the Chicot aquifer and part or all of the Evangeline aquifer. No measurable compaction was observed within the Jasper aquifer or within deeper strata. It should be noted that no borehole extensometers are currently located in Montgomery County, meaning the distribution of subsidence between aquifers is not well defined in that area.

Model estimates of future subsidence in Montgomery County are ambiguous. The previous version of the Northern Portion of the Gulf Coast Aquifer System model (Kasmarek and others, 2005) included predictive runs to assess future subsidence from compaction in the Chicot and Evangeline aquifers based on two different future water use scenarios. Using TWDB estimates for future water use, the previous model predicted isolated areas with four feet of subsidence near the southern border of Montgomery County by 2010 and over five feet in the Conroe area (Figure 6-16). However, available data do not indicate that this amount of subsidence has occurred. The documentation for the current groundwater availability model (Kasmarek and others, 2012) does not include data or results of any predictive model runs to evaluate future subsidence.

6.6 Socioeconomic Impacts

Summary: *The TWDB does not know what basis must be used by groundwater conservation districts to meet the requirement of considering the socioeconomic impacts reasonably expected to occur and, therefore, cannot make any determination with regard to whether the requirement was met by the explanatory report.*

Texas Water Code § 36.108(d) requires that groundwater management area district representatives must consider the “socioeconomic impacts reasonably expected to occur.”

For the purpose of this evaluation, the TWDB has not attempted to prepare an independent quantitative or qualitative evaluation of socioeconomic impacts associated with the adoption of desired future conditions and could not do so since the TWDB does not know what the basis would be for performing such an evaluation including to which alternative condition(s) potential or proposed desired future conditions impacts must be compared.

6.7 Private Property Rights

Summary: *The evaluation of private property rights requires a focus on political and legal issues that are beyond the scope of this technical and scientific evaluation. Therefore, the TWDB did not evaluate the impact of the adopted desired future conditions on private property rights.*

In general, private property rights can come into play in the development of desired future conditions based on the fact that groundwater in place is considered private property by Texas law and courts. The management of groundwater in Texas is governed by the rule of capture, subject to certain limitations, and the legal premise that an interest in groundwater in place is a real property interest. The rule of capture states that a landowner may pump an unlimited amount of water from below his property and he is not liable should his pumping drain the water below his neighbor's property. However, a landowner may not cause willful and wanton waste of the resource and may be subject to a suit for damages if his negligent pumping causes subsidence of neighboring properties. Furthermore, the management of groundwater in Texas is subject to regulation by groundwater conservation districts. These districts may govern groundwater through means such as production limits, well spacing, drilling permits, and reporting requirements within the areas they govern. However, although districts have the authority to regulate groundwater in these ways, recent court cases in Texas may change the landscape of groundwater law. In *Edwards Aquifer Authority v. Day*, the Texas Supreme court held that groundwater pumping limits may constitute a regulatory taking because groundwater in place is a property right. The first case in which a landowner successfully sued a district under this premise is *Edwards Aquifer Authority v. Bragg*, which is still subject to appeal by the district as to certain elements. It is unclear exactly how these recent court cases will affect the broad scope of groundwater law in Texas because of the unique nature of the Edwards Aquifer Authority, which was created differently than other districts.

6.8 Feasibility of Achieving the Desired Future Condition

Summary: *The feasibility of achieving the desired future condition by the District is affected, broadly speaking, by groundwater management decisions and actions by the District and by other entities in surrounding areas, and by hydrogeologic conditions locally within the*

District and regionally in areas surrounding the District. The desired future conditions for individual districts are feasible because the district representatives in Groundwater Management Area 14 adopted regional desired future conditions based on regional hydrogeologic and groundwater conditions. However, it is possible that actions occurring outside the District could impact the ability of the District to achieve the desired future conditions.

The feasibility of achieving the desired future condition by the District is affected, broadly speaking, by two factors:

1. Groundwater management decisions and actions by the District and by other entities in surrounding areas, and
2. Hydrogeologic conditions locally within the District and regionally in areas surrounding the District.

Groundwater Management Activities

Groundwater conservation districts are required by Texas Water Code § 36.1132 to manage groundwater production on a long-term basis to achieve an applicable desired future condition. This requirement is addressed on the local level through the implementation of a district's groundwater management plan and adopted rules, as authorized by state law. State law also addresses the regional aspect of groundwater management involving districts with common aquifers. Texas Water Code § 36.108(b) and (c) require districts in a groundwater management area to meet at least annually to compare groundwater management plans and activities to consider the degree to which each management plan achieves the desired future conditions established during the joint planning process. This process would enable an individual district to be aware of neighboring districts' policies or activities that could affect the ability of the district to achieve a desired future condition in a shared aquifer that exhibits groundwater flow conditions that extend beyond political boundaries. However, for areas that do not have a groundwater conservation district (such as Liberty County, which borders the District), a district may be either unaware of or unable to prevent groundwater production occurring in unregulated areas that are hydraulically connected to shared aquifers. This could have the possible consequence of affecting the ability of a district to partially or completely achieve meeting its desired future condition.

Hydrogeologic Conditions

The district representatives adopted desired future conditions for the entire Gulf Coast Aquifer System in Groundwater Management Area 14. These desired future conditions state that the average drawdown in the various aquifer units of the Gulf Coast Aquifer System should not exceed the following values after 61 years:

- 28.3 feet for the Chicot Aquifer
- 23.6 feet for the Evangeline Aquifer
- 18.5 feet for the Burkeville confining unit
- 66.2 feet for the Jasper Aquifer

These are regional desired future conditions, developed through evaluation of hydrologic conditions and input from individual districts concerning their understanding of existing and projected groundwater usage in terms of magnitude and distribution of pumping. While they are regionally-based, they are also expressed as individual, district-level desired future conditions, each of which must be individually achieved in order for the regional desired future conditions to be satisfied. This is a function of the hydraulic connectivity of the shared aquifers of the Gulf Coast Aquifer System. Previous sections of this document have illustrated the regional nature of the Gulf Coast Aquifer System and how groundwater pumping in one area may lead to measurable declines in water levels far away from the area of pumping. If an individual district fails to implement management practices designed to achieve the desired future condition, or if unanticipated groundwater production develops in unregulated areas of the groundwater management area, then the feasibility of achieving a desired future condition for any particular district could be threatened.

6.9 Other Information

This section addresses other information relevant to the evaluation of the scientific and technical aspects of the desired future conditions adopted by the District. The petition references a TWDB memo (Appendix B) concerning the use of "geographic areas" in establishing desired future conditions. The memo, dated March 10, 2010, was authored by William R. Hutchison and Kenneth L. Petersen and directed to members of the TWDB Board. Quoting from the memorandum:

> **(b) Use of "geographic areas" in establishing desired future conditions**
>
> Section 36.108(d) provides that groundwater conservation districts "shall consider uses or conditions of an aquifer within the management area that differ substantially from one geographic area to another" when establishing desired future conditions. However, the law does not define "geographic area" and there is no guidance to the districts either on how to delineate a geographic area or on how to measure "substantial" differences between geographic areas in either uses or conditions. Under Section 36.108(d)(2), districts may establish different desired future conditions within a management area for "each geographic area overlying an aquifer in whole or in part…within the boundaries of the management area."

> The question has been presented whether groundwater conservation districts within a groundwater management area (GMA) may delineate different "geographic areas" within the GMA by use of county (or other political subdivision) boundaries. Staff believes this approach is legally defensible provided the districts are using the political subdivision boundaries to locate discernible and substantial differences in uses or conditions with the GMA and not for any other purpose. It should be emphasized that employing geographic areas that are not based on clear and substantial differences in uses or aquifer conditions is not supportable, regardless of how those geographic areas are drawn.

Texas Water Code § 36.108(d-4) requires a district to "adopt the desired future conditions in the resolution and report that apply to the district." As documented in this scientific and technical report and discussed in the explanatory report, the desired future conditions were developed with the assistance of the applicable regional groundwater availability model that incorporates regional, trans-district hydrogeologic and hydrologic properties. The district representatives adopted regional, groundwater management area-wide desired future conditions (Section 6.8). Within the groundwater management area there are variations in physical conditions (such as aquifer thickness, current drawdown, and permeability) as well as aquifer uses (such as municipal and exempt uses that vary between urban and rural areas). These variations naturally contribute to the individual desired future conditions that are valid for different counties and districts that, taken together, contribute to the overall regional desired future conditions for the aquifers.

7.0 Groundwater Availability Model

TWDB's Executive Administrator accepted the groundwater availability model for the northern part of the Gulf Coast Aquifer System version 3.01 (also known as the Houston Area Groundwater Model version 1.1; Figures 7-1 and 7-2) for use in its groundwater modeling program on February 18, 2014 (Appendix C). The review concluded that the updated U.S. Geological Survey model (Kasmarek, 2012) was an improvement over the previous groundwater availability model for the northern part of the Gulf Coast Aquifer System (version 2.01; Kasmarek and Robinson, 2004). Improvements included extending the historical model period closer to the present day (2009 versus 2000), implementing land surface subsidence capabilities in all model layers rather than just the Chicot and Evangeline Aquifers (model layers 1 and 2), and a better fit between model calculated water levels and water level data (Wade and others, 2013; Kasmarek, 2012).

Consultants for Groundwater Management Area 14 developed a proposed predictive pumping scenario for the Gulf Coast Aquifer System (Groundwater Management Area 14, 2016). Pumping for the predictive period after 2009 was based on three sources: (1) TWDB GAM Run 10-023 (Oliver, 2010), a predictive pumping scenario from the first round of desired future conditions in 2010; (2) pumping incorporated into the model as part of the Regional Groundwater Update Project (Freese and Nichols and others, 2013); and (3) the regulatory limits imposed by the Lone Star Groundwater Conservation District regulatory plan (Groundwater Management Area 14, 2016; Appendix F). The predictive pumping scenario was used in the groundwater availability model to calculate aquifer water levels in 2070 after pumping for 61 years. The average water-level drawdowns from 2009 to 2070 were then calculated for each county. The county average drawdowns and the total county pumping were summarized in a memorandum report on December 11, 2015 (Groundwater Management Area 14, 2016; Appendix F).

The TWDB ran the groundwater availability model (version 3.01) for the northern part of the Gulf Coast Aquifer System using the model files submitted with the explanatory report (Groundwater Management Area 14, 2016; Appendix F). As part of the process to calculate modeled available groundwater, the TWDB checked the model files submitted by Groundwater Management Area 14 to determine if the groundwater pumping scenario was compatible with the adopted desired future conditions. The TWDB used these model files to extract model-calculated water levels for 2009 and 2070, and drawdown was calculated as the difference between water levels in 2009 and water levels in 2070. There was some mismatch between the calculated average drawdowns and the desired future conditions for a few counties. The TWDB communicated this discrepancy to Groundwater Management Area 14 and an updated pumping file was provided by the Groundwater

Management Area 14 consultants on October 26, 2016. The updated model pumping file produced a better match for the adopted desired future conditions (Wade, 2016).

The modeled available groundwater values were determined by extracting pumping rates by decade from the model results. Modeled available groundwater values consisted of the annual pumping rates divided by county, river basin, regional water planning area, and groundwater conservation district within Groundwater Management Area 14 (Wade, 2016).

8.0 Published Studies

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Figures

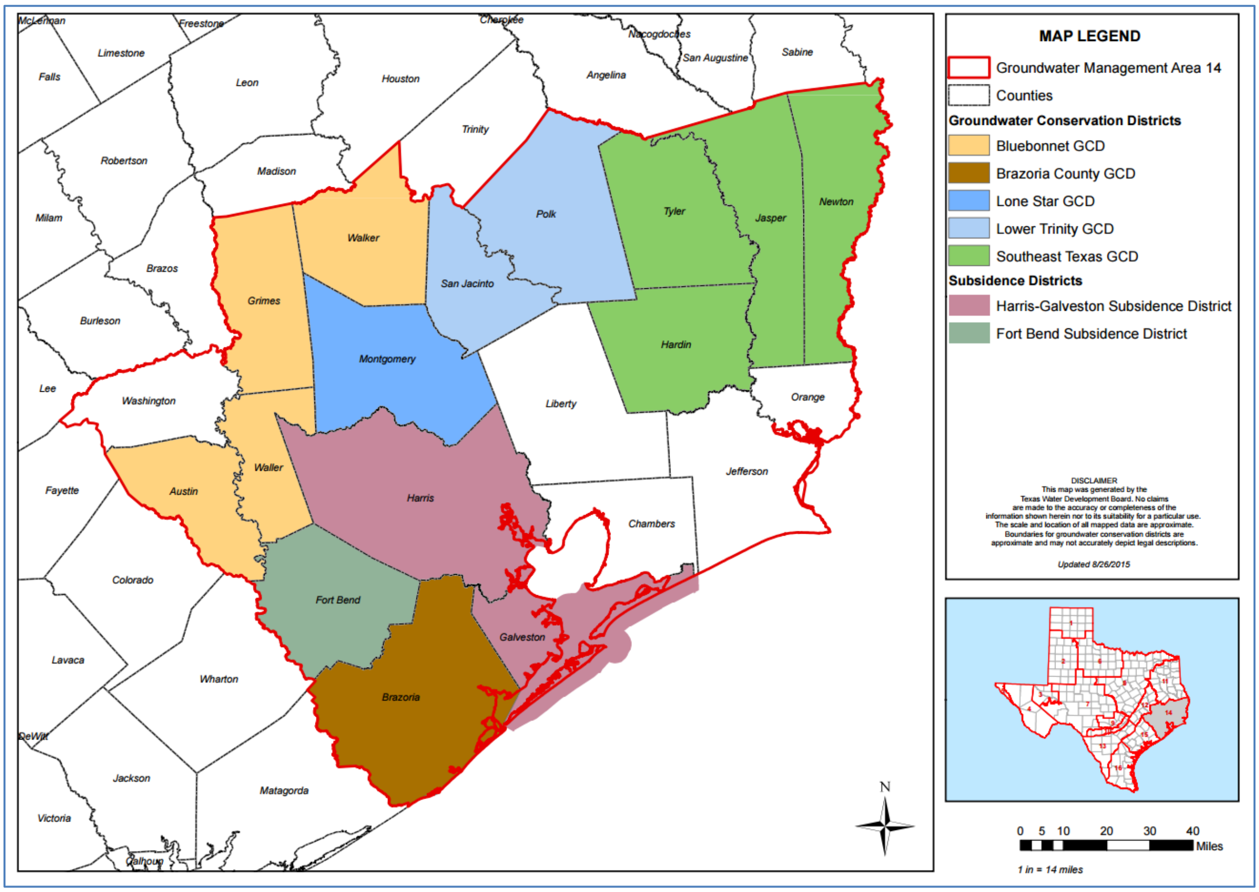


Figure 1-1. Map of Groundwater Management Area 14 and the Lone Star Groundwater Conservation District

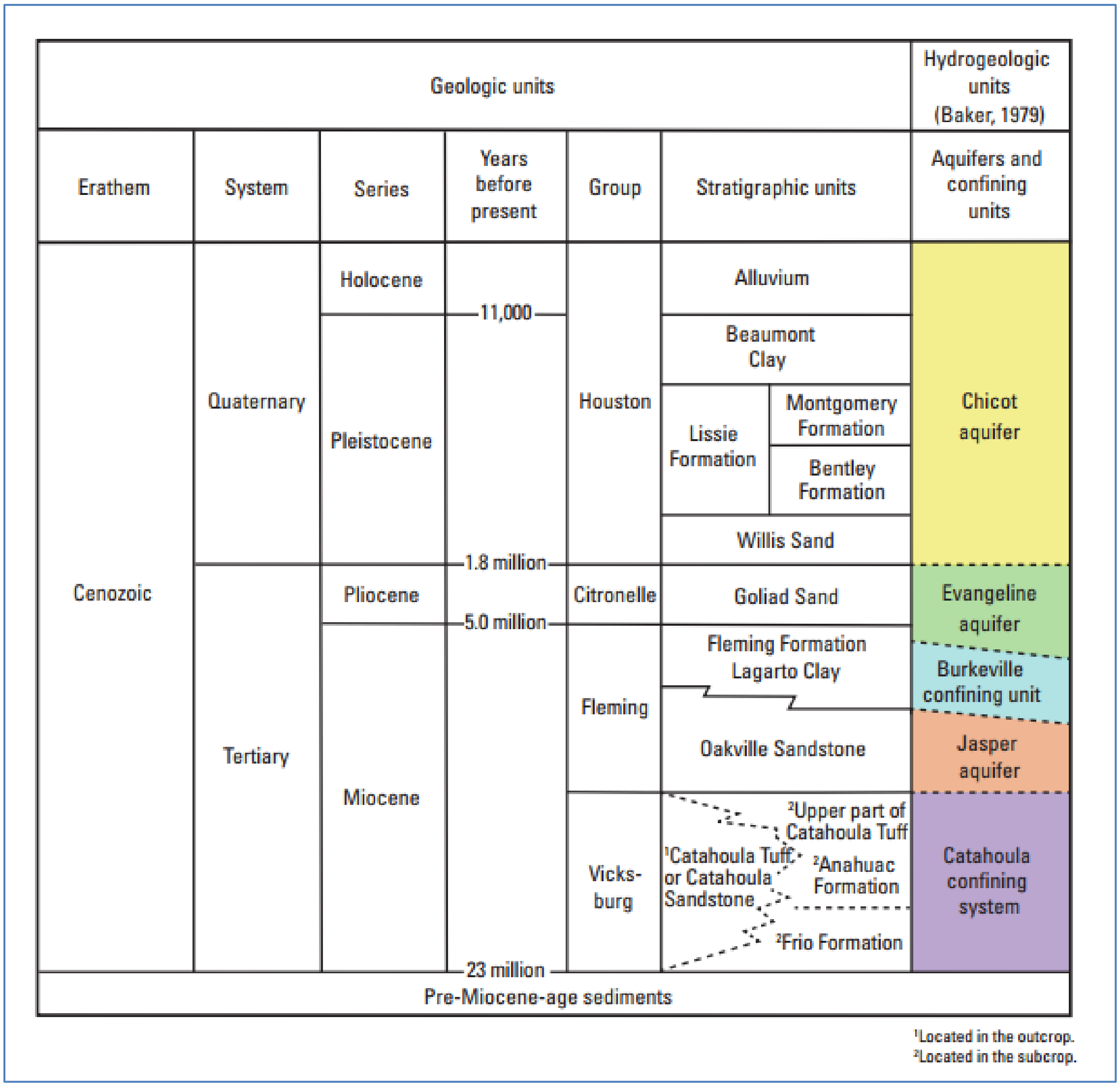


Figure 3-1. Geologic and hydrogeologic units (aquifers) of the northern Gulf Coast Aquifer System (from Kasmarek and others, 2016).

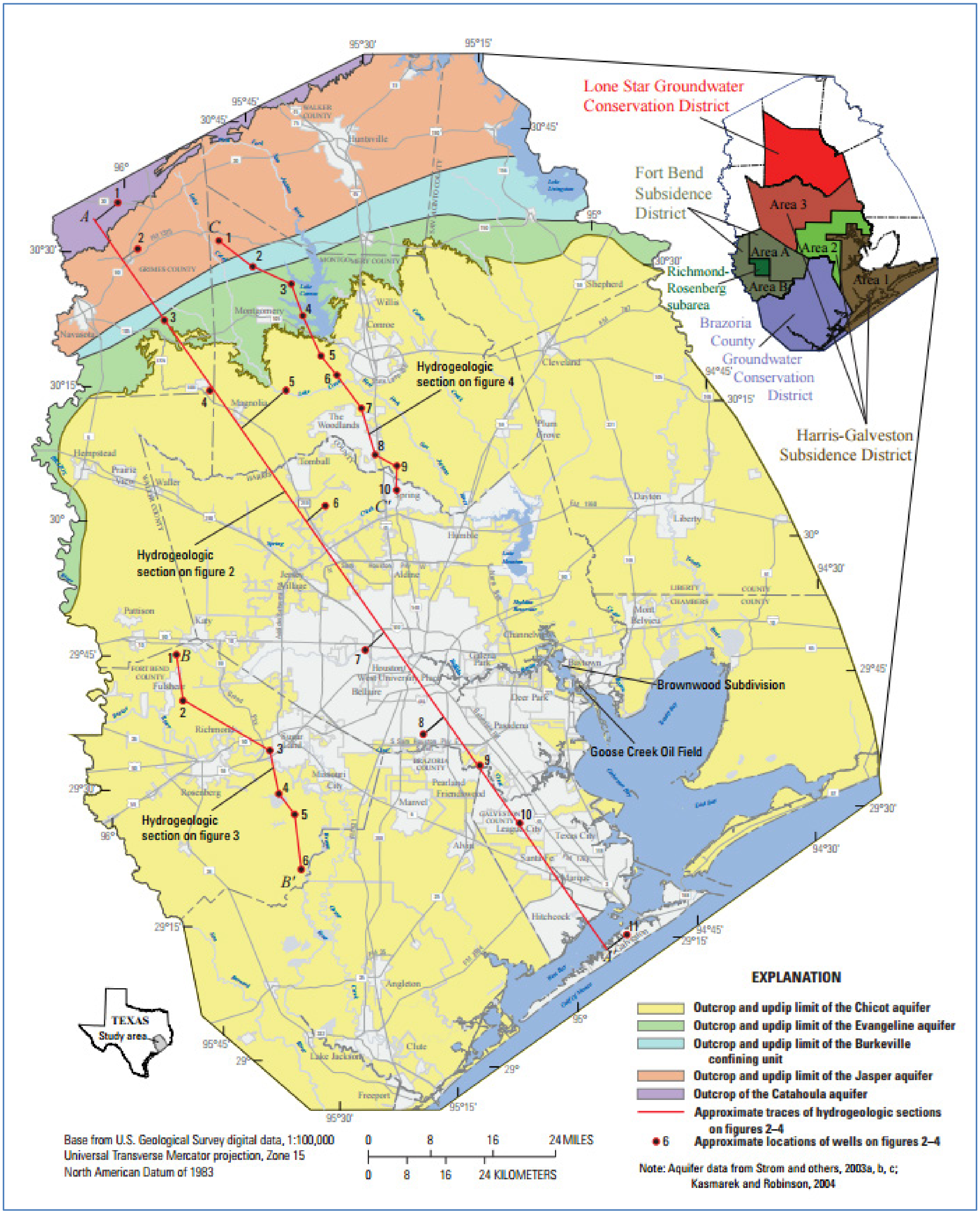


Figure 3-2. Map of relevant aquifers in the northern Gulf Coast region (from Kasmarek and others, 2016)

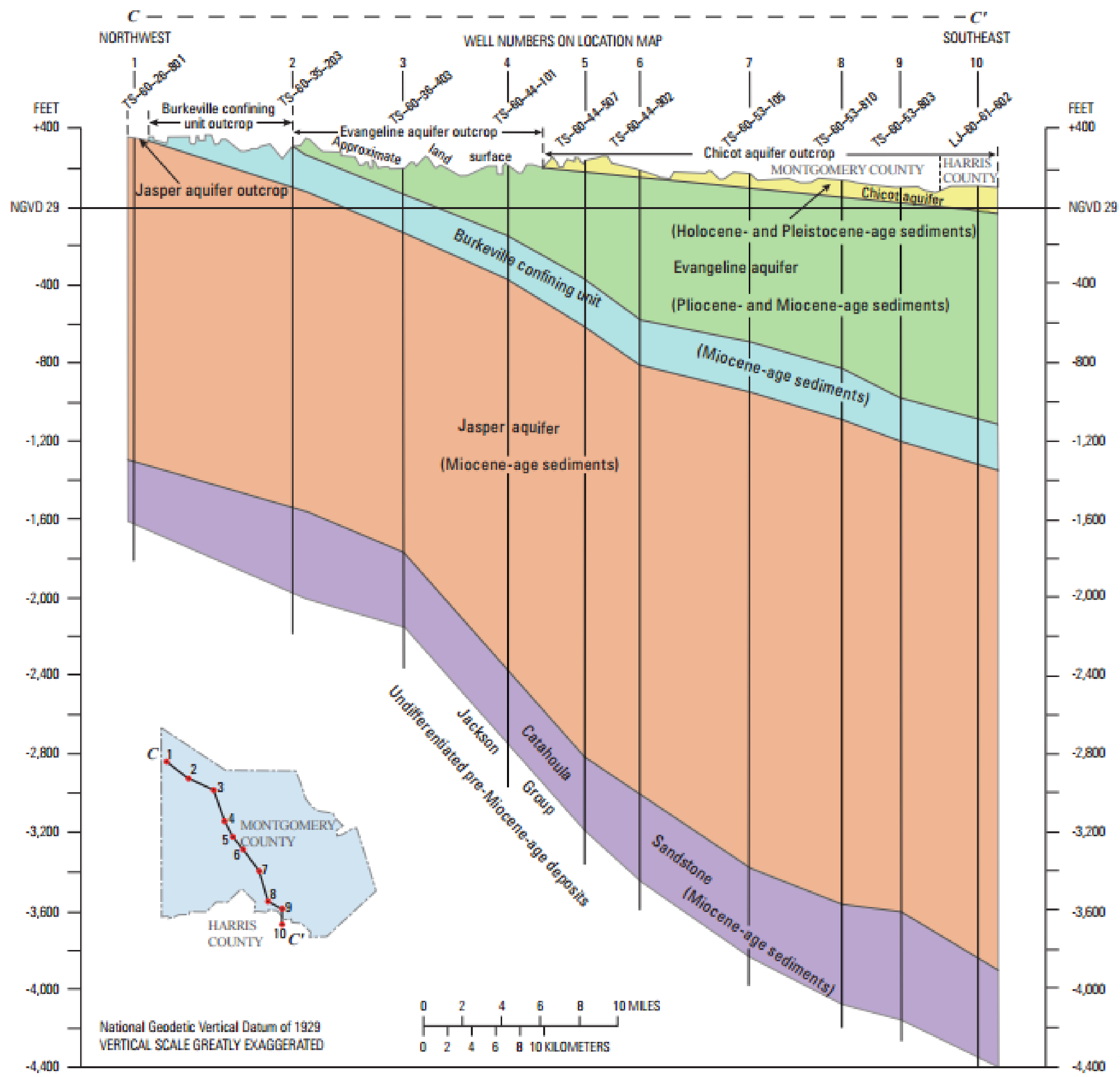


Figure 3-3. Cross-Section of Gulf Coast Aquifer System in Montgomery County (from Kasmarek and others, 2016).

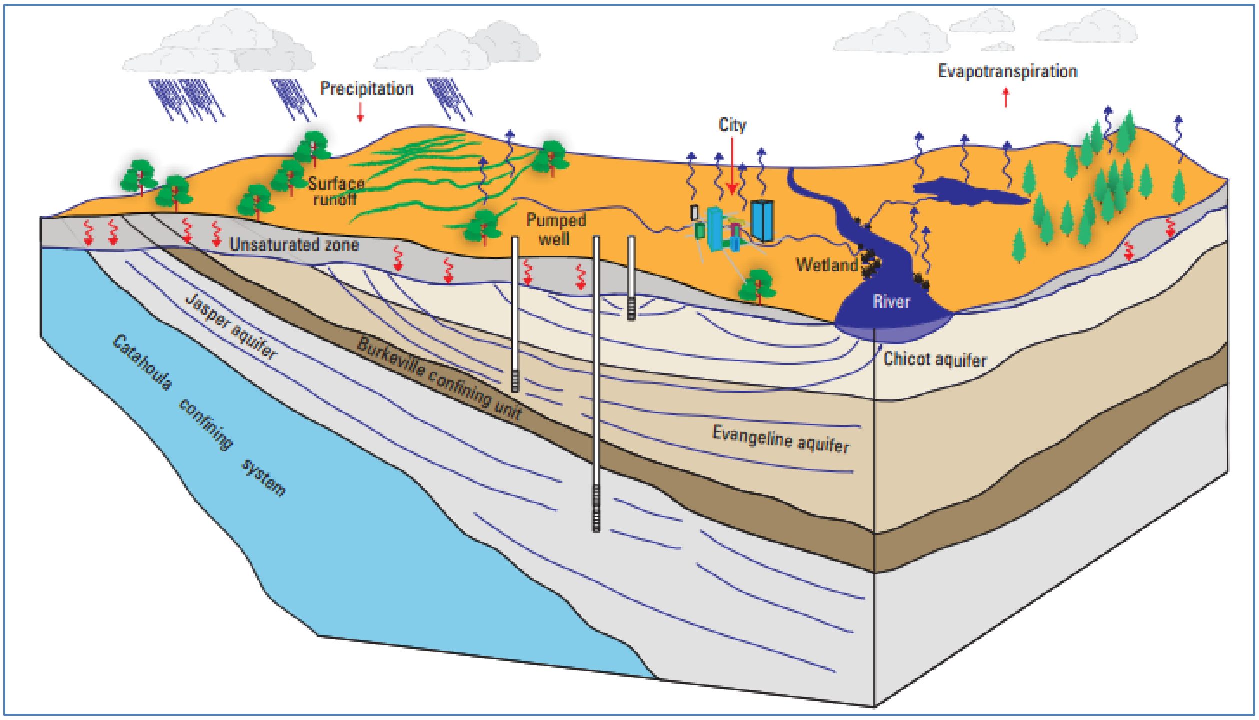


Figure 3-4. Conceptual model diagram of groundwater flow and the hydrologic cycle in Montgomery County (Oden and Delin, 2013).

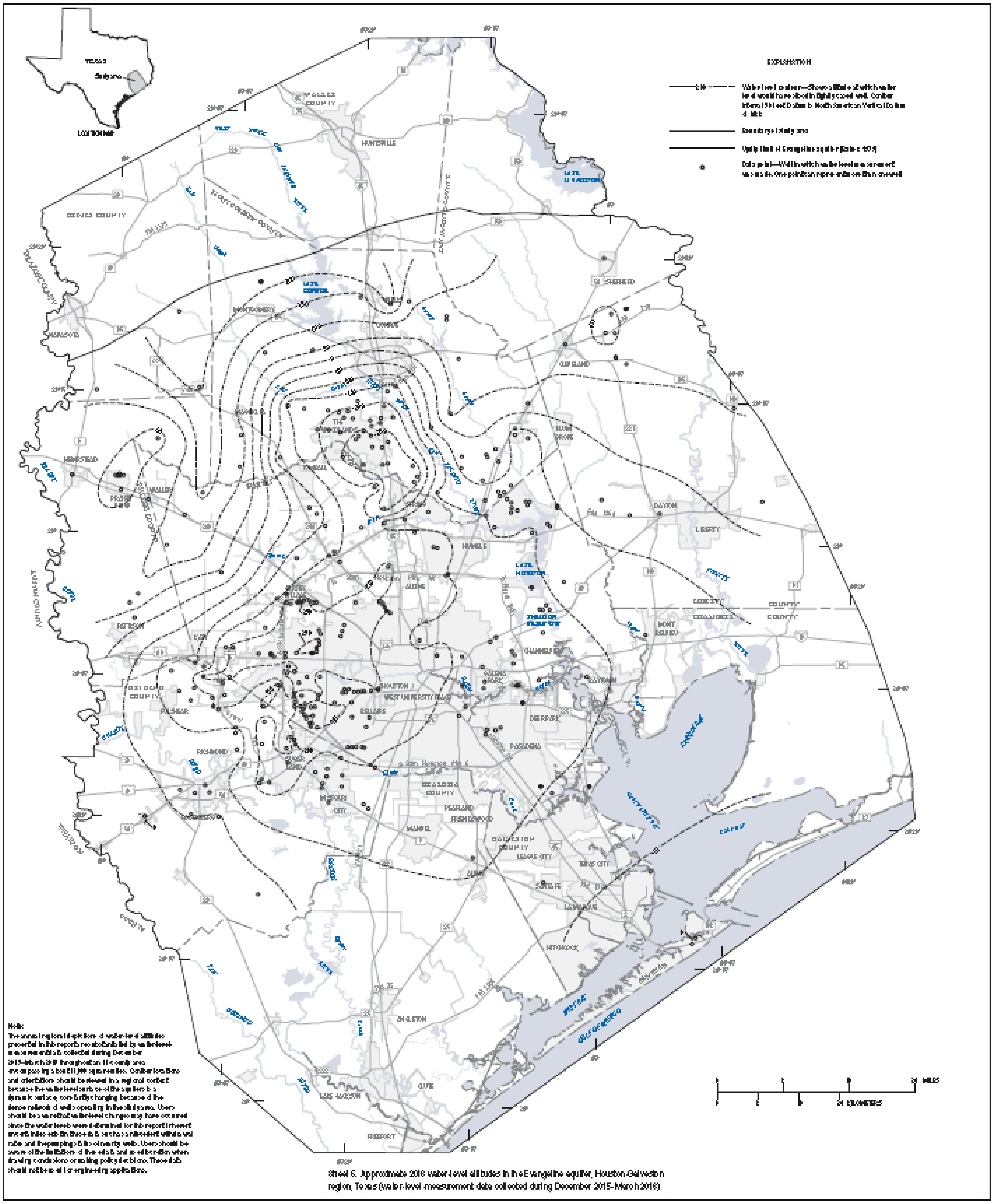


Figure 3-5. Map showing approximate 2016 water-level altitudes in the Evangeline Aquifer, Houston-Galveston region (from Kasmarek and others, 2016).

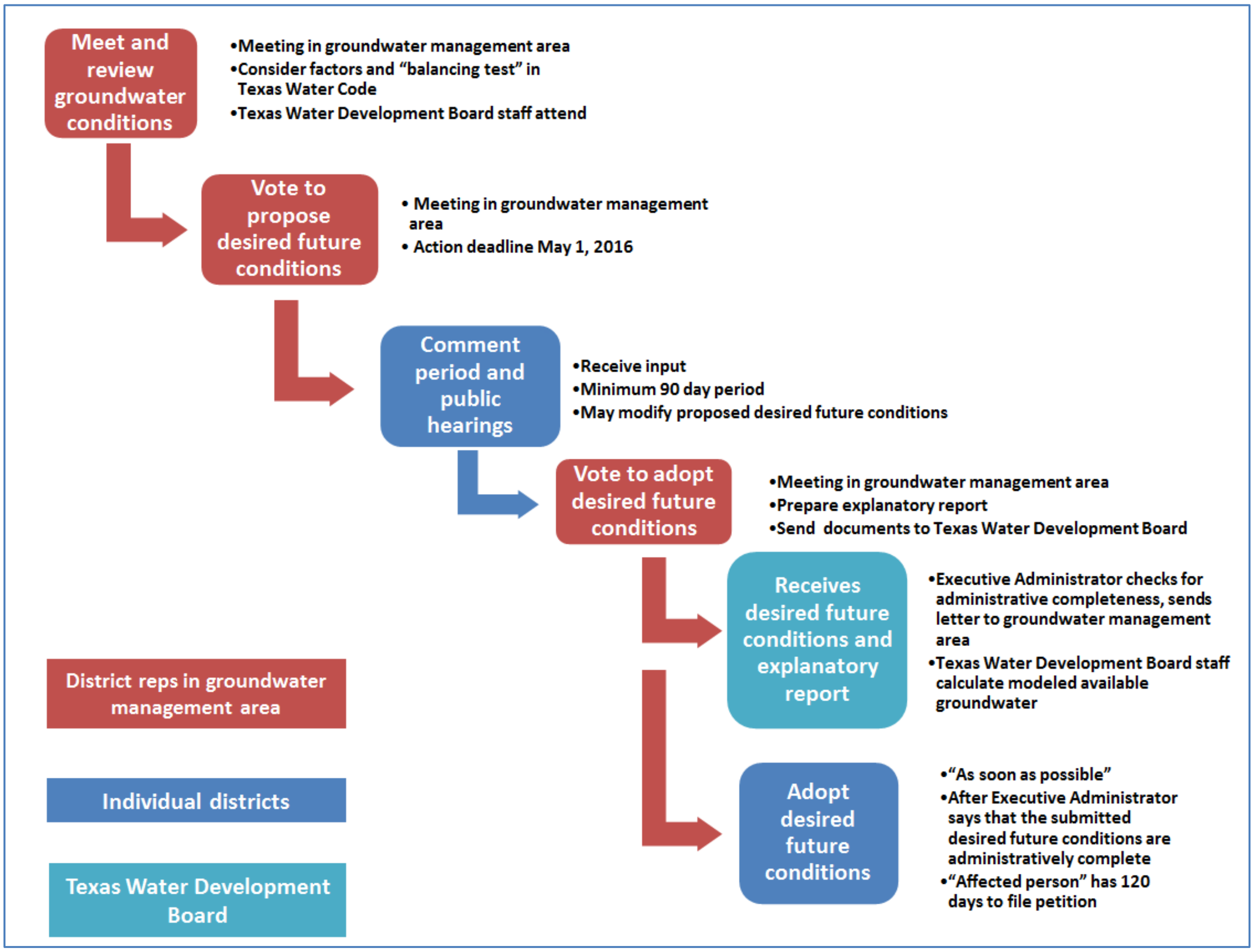
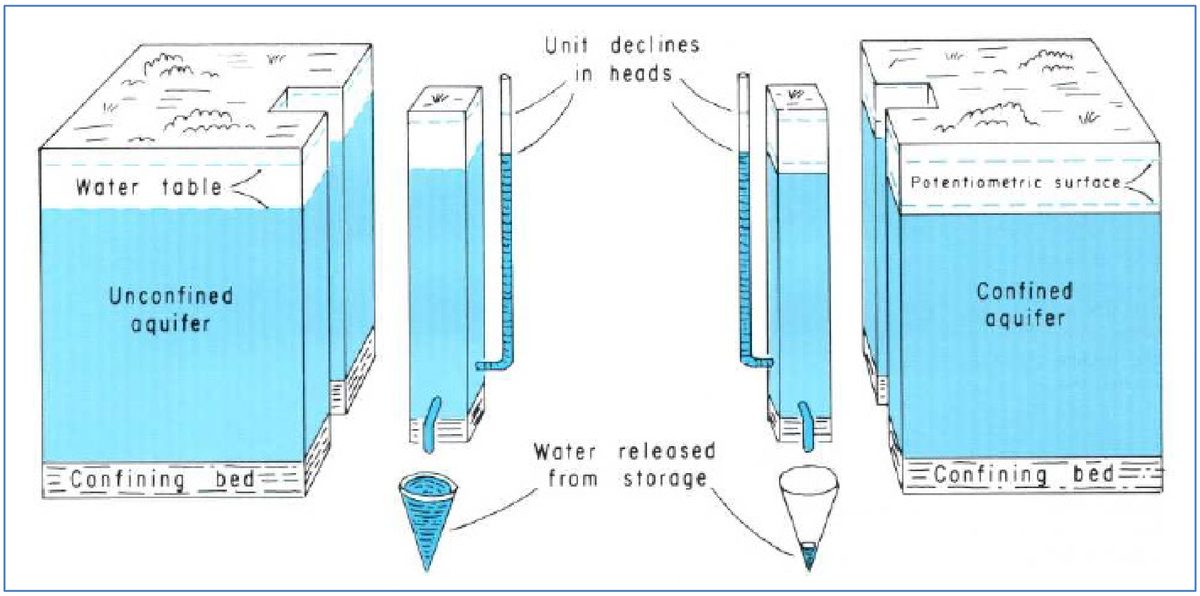


Figure 4-1. Diagram of major activities in joint planning by groundwater conservation districts.



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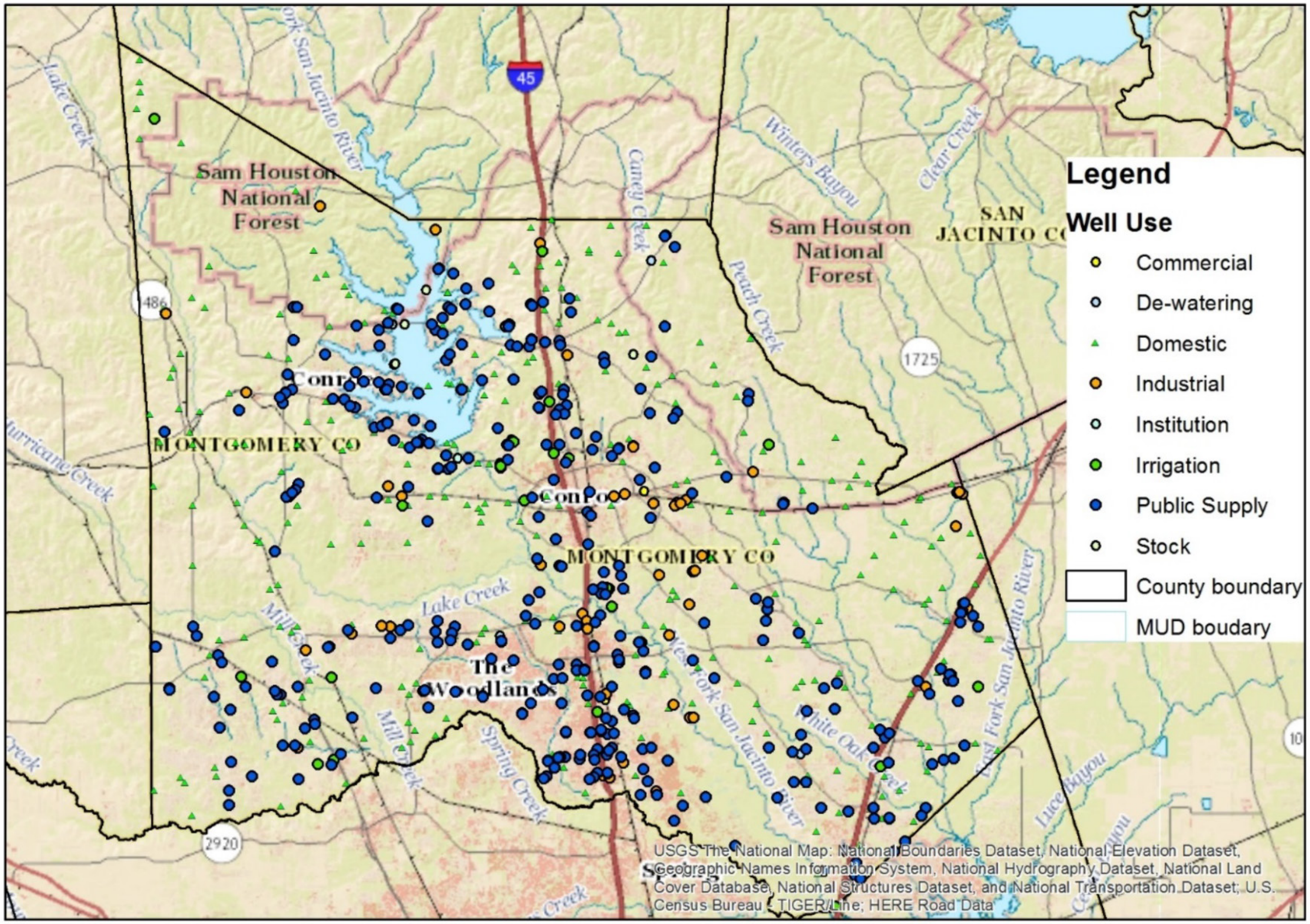

Figure 6-1. Locations and types of wells recorded in the TWDB groundwater database in the Lone Star Groundwater Conservation District

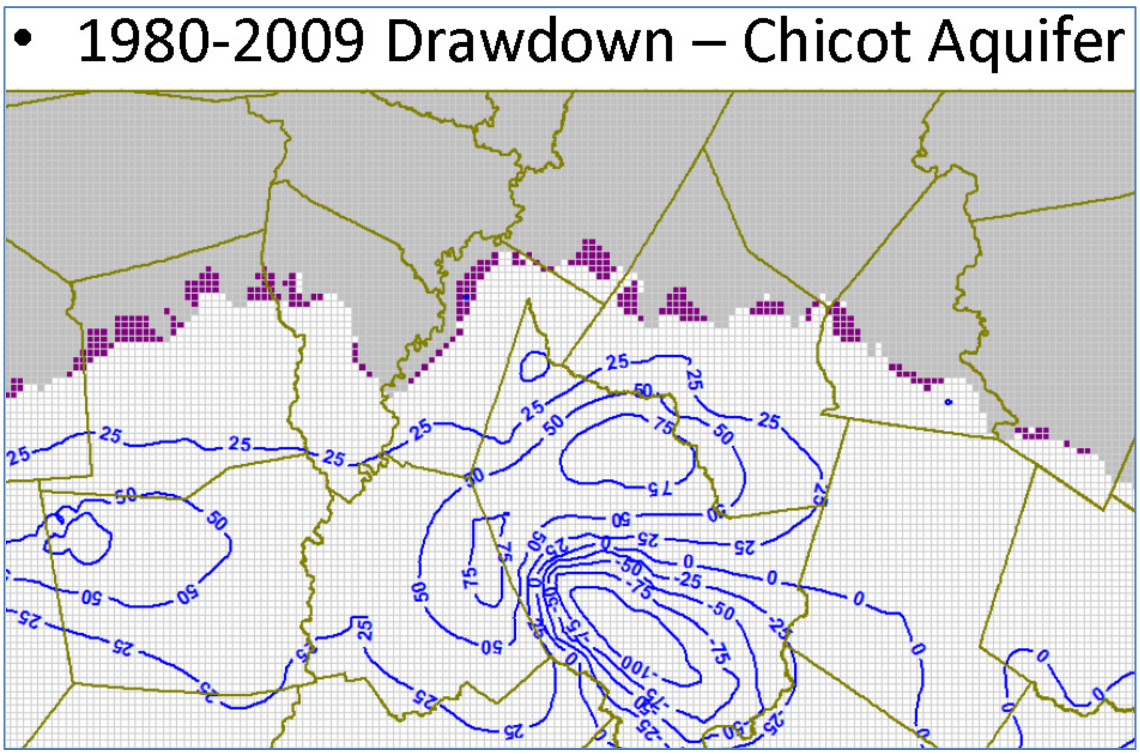

Figure 6-2. Cumulative drawdown (through 2009) in the Chicot Aquifer (from Groundwater Management Area 14, 2016; Appendix J)

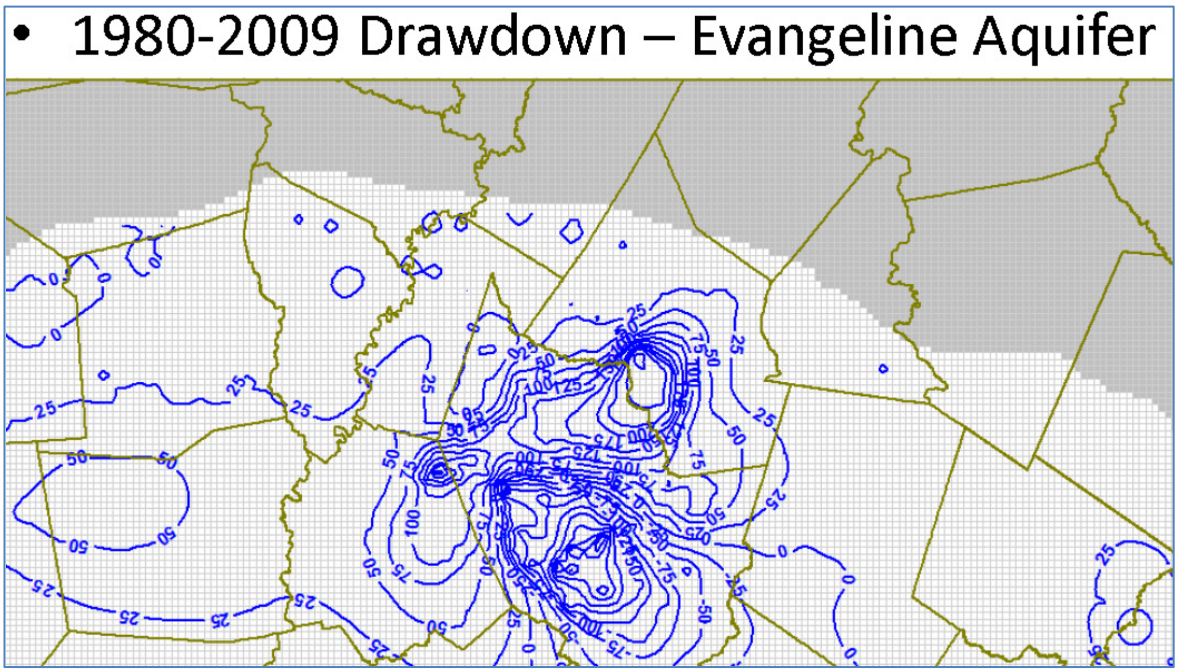

Figure 6-3. Cumulative drawdown (through 2009) in the Evangeline Aquifer (from Groundwater Management Area 14, 2016; Appendix J)

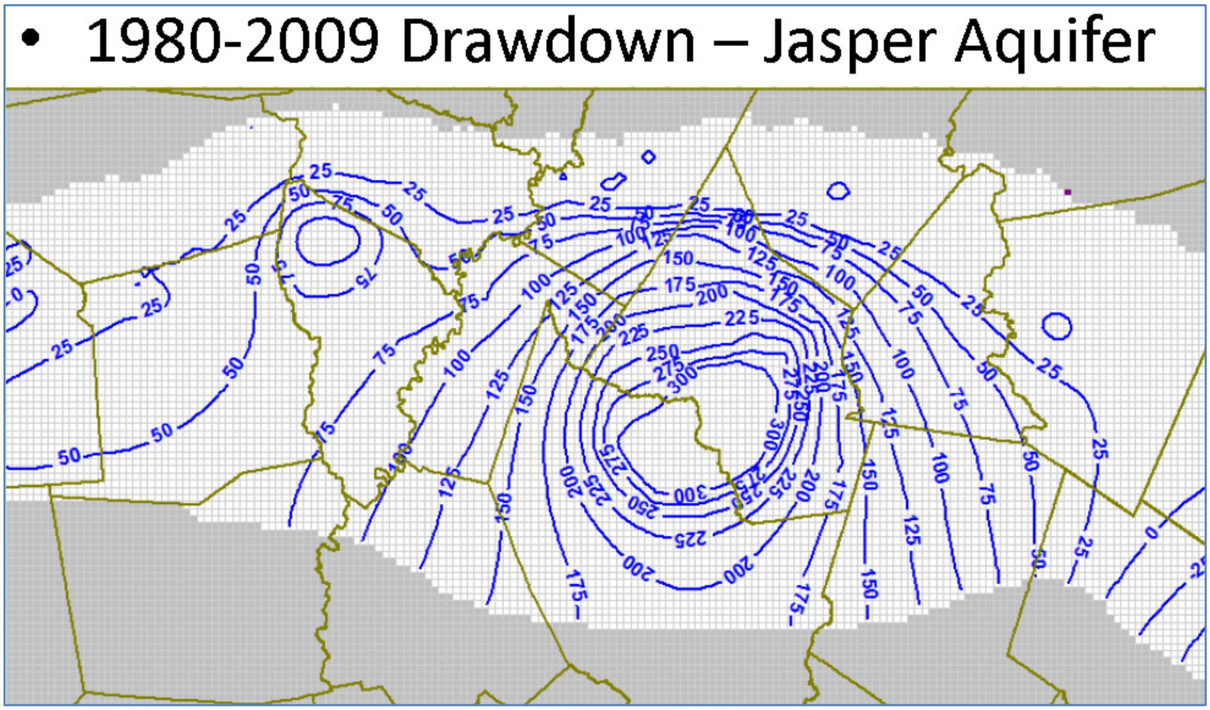

Figure 6-4. Cumulative drawdown (through 2009) in the Jasper Aquifer (from Groundwater Management Area 14, 2016; Appendix J)

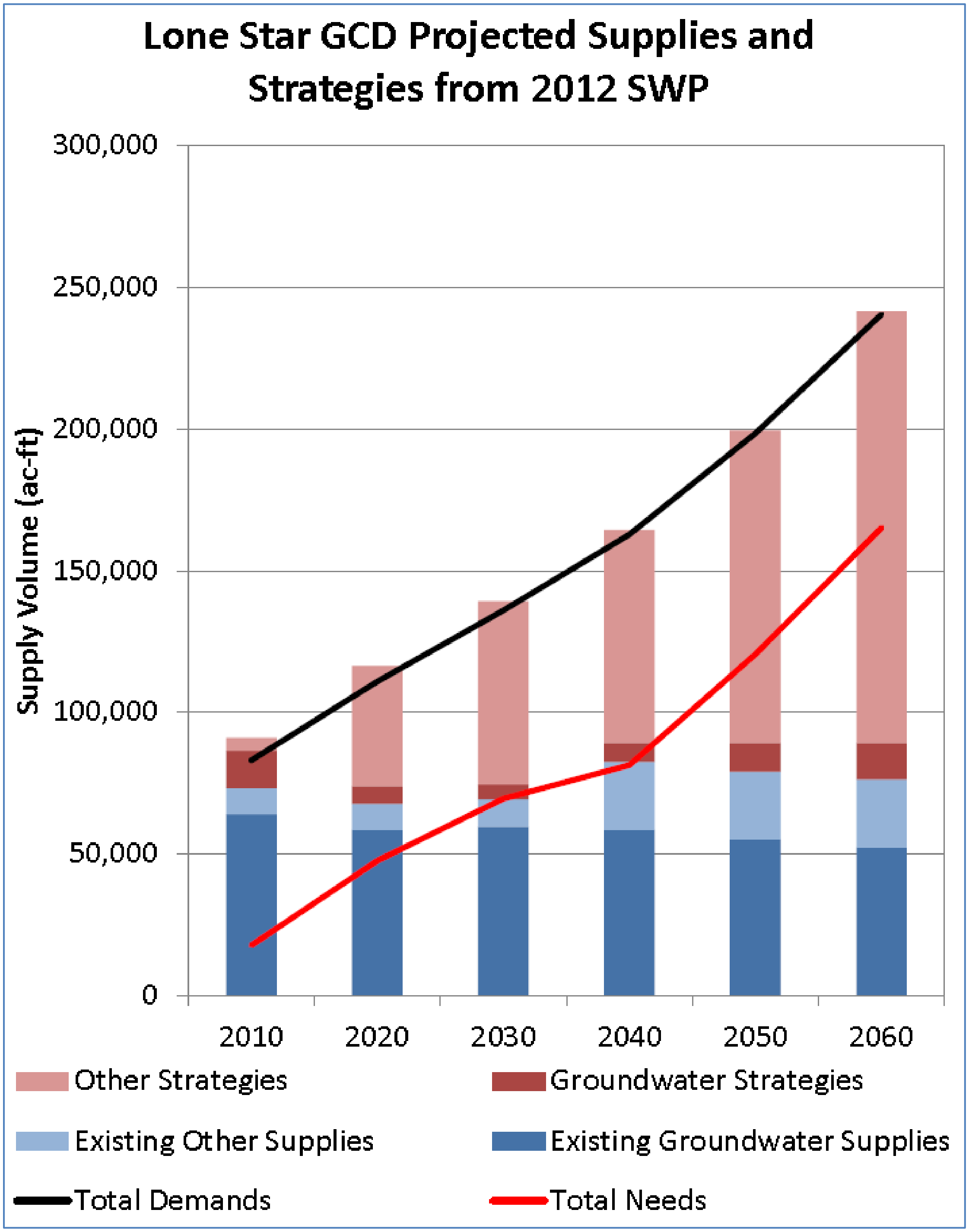

Figure 6-5. Graph of projected supplies and strategies from the 2012 State Water Plan (from Groundwater Management Area 14, 2016; Appendix I)

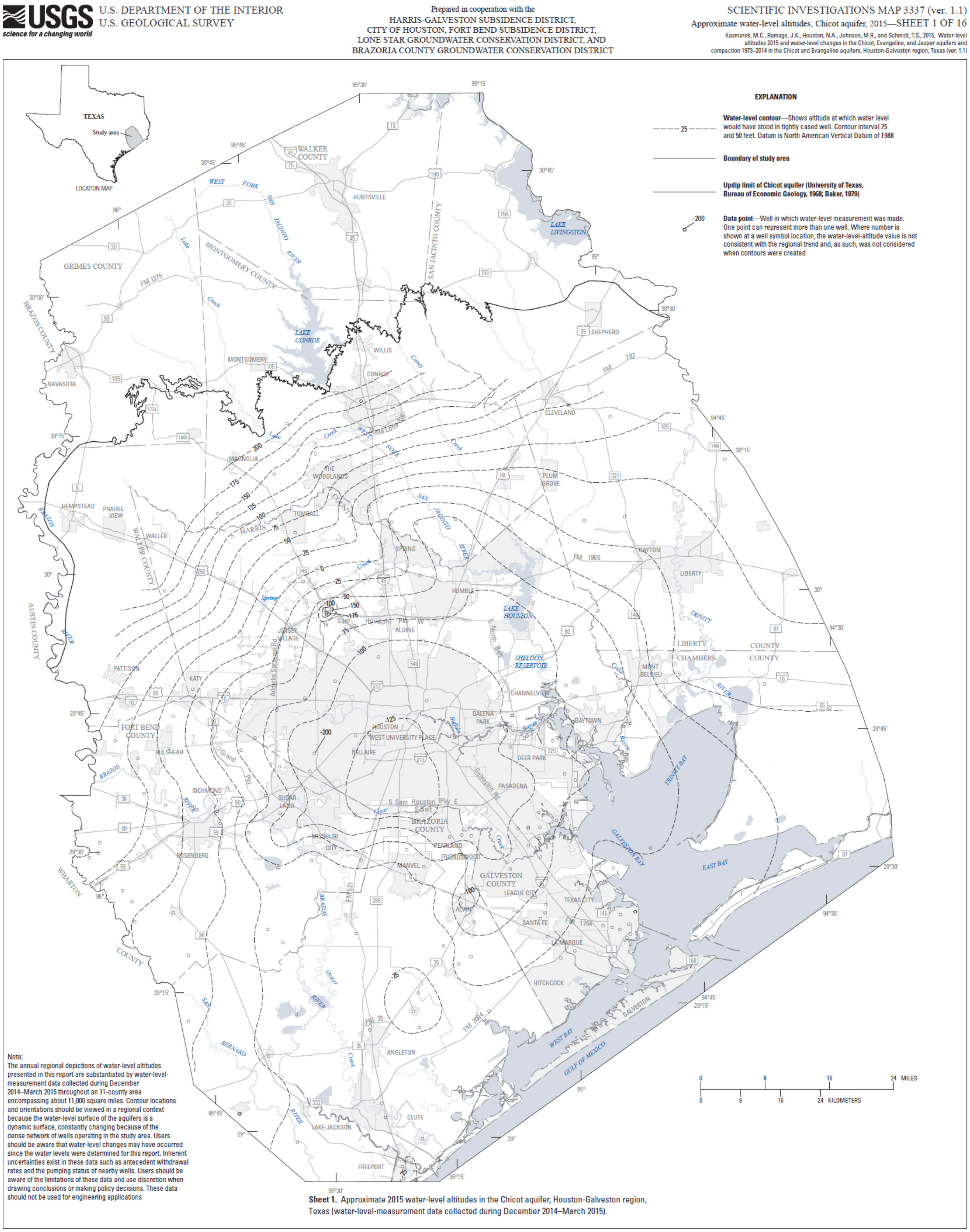

Figure 6-6. 2015 Potentiometric surface map for the Chicot Aquifer (from Kasmarek and others, 2015).

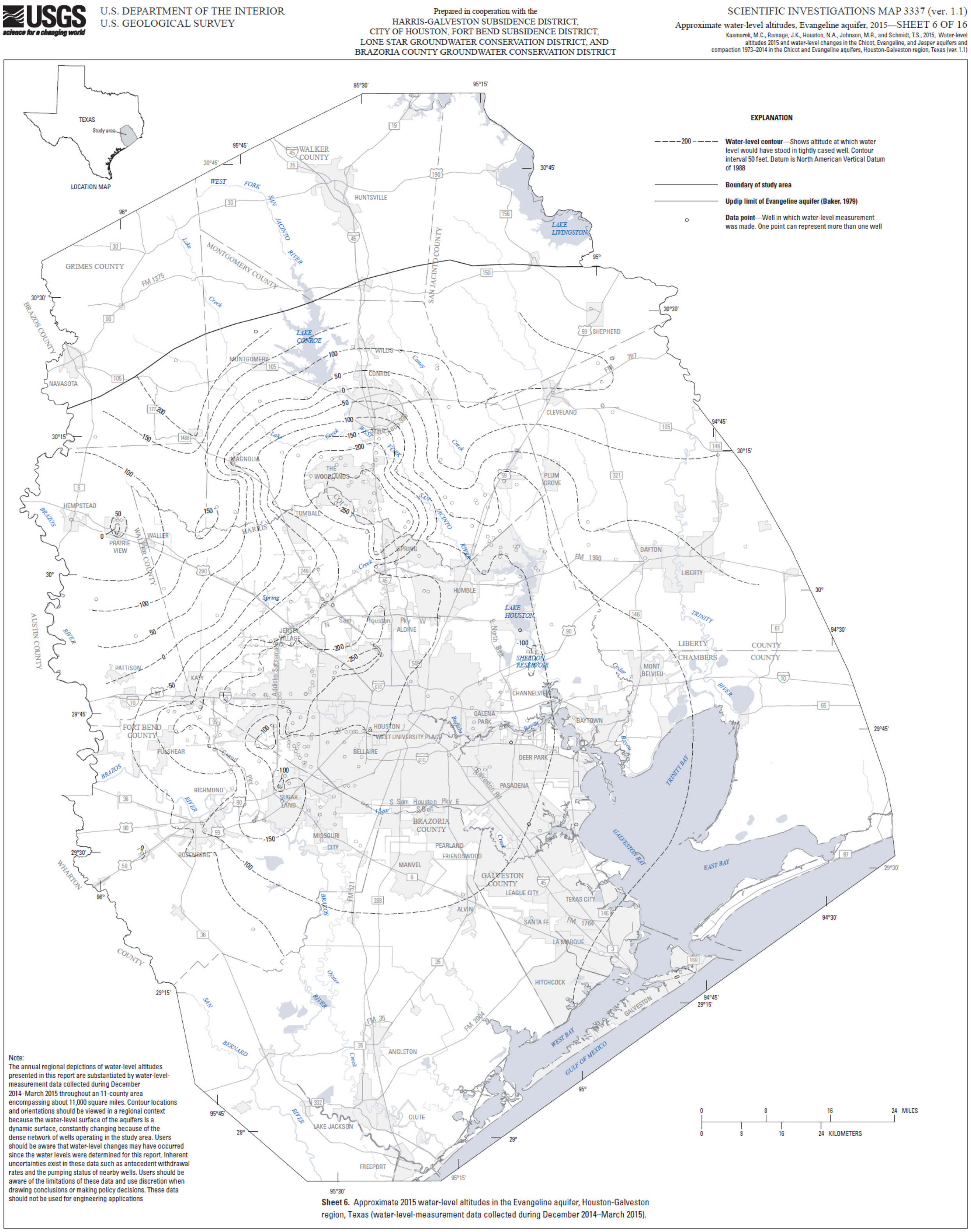

Figure 6-7. 2015 Potentiometric surface map for the Evangeline Aquifer (from Kasmarek and others, 2015).

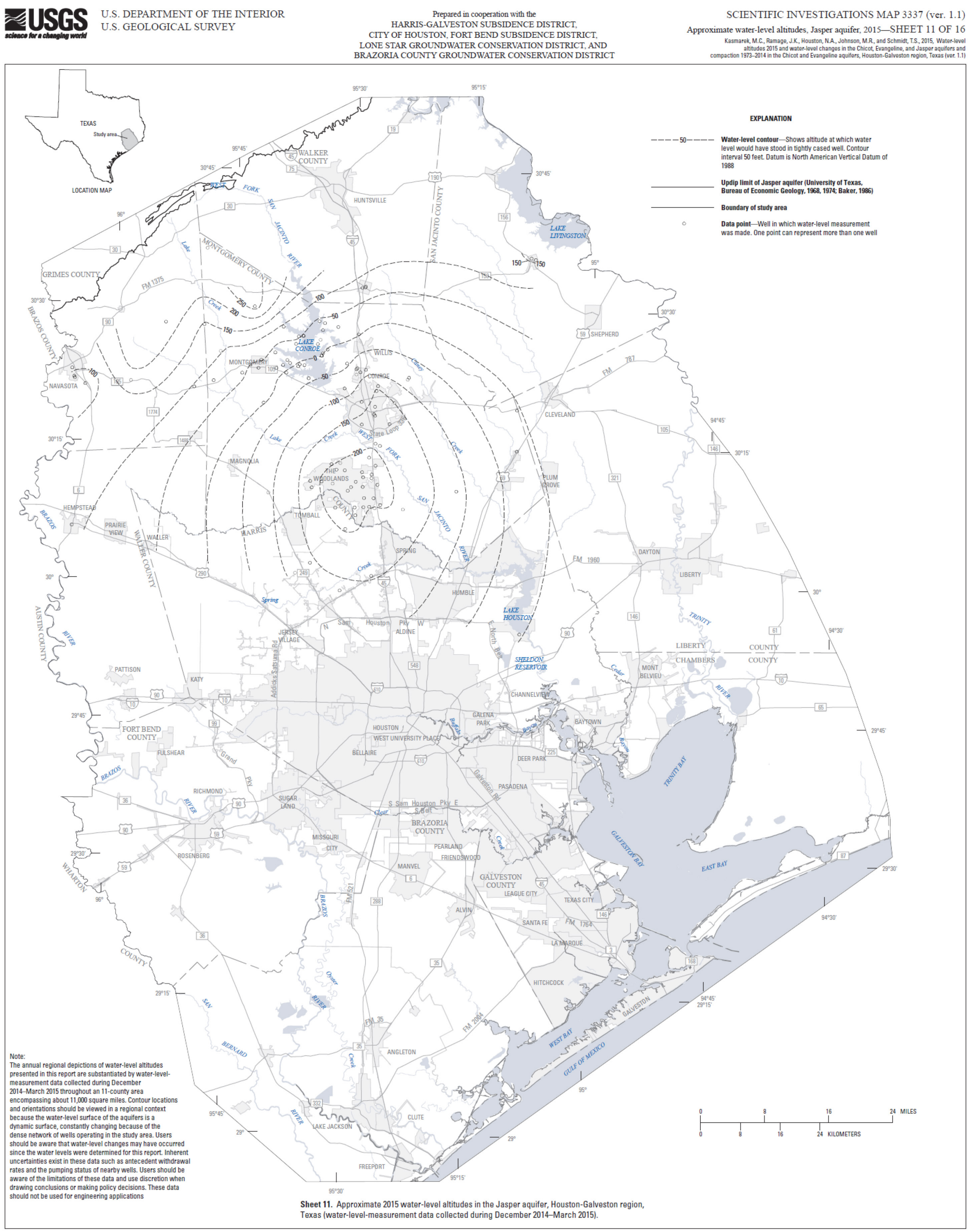

Figure 6-8. Potentiometric surface map for the Jasper Aquifer (from Kasmarek and others, 2015).

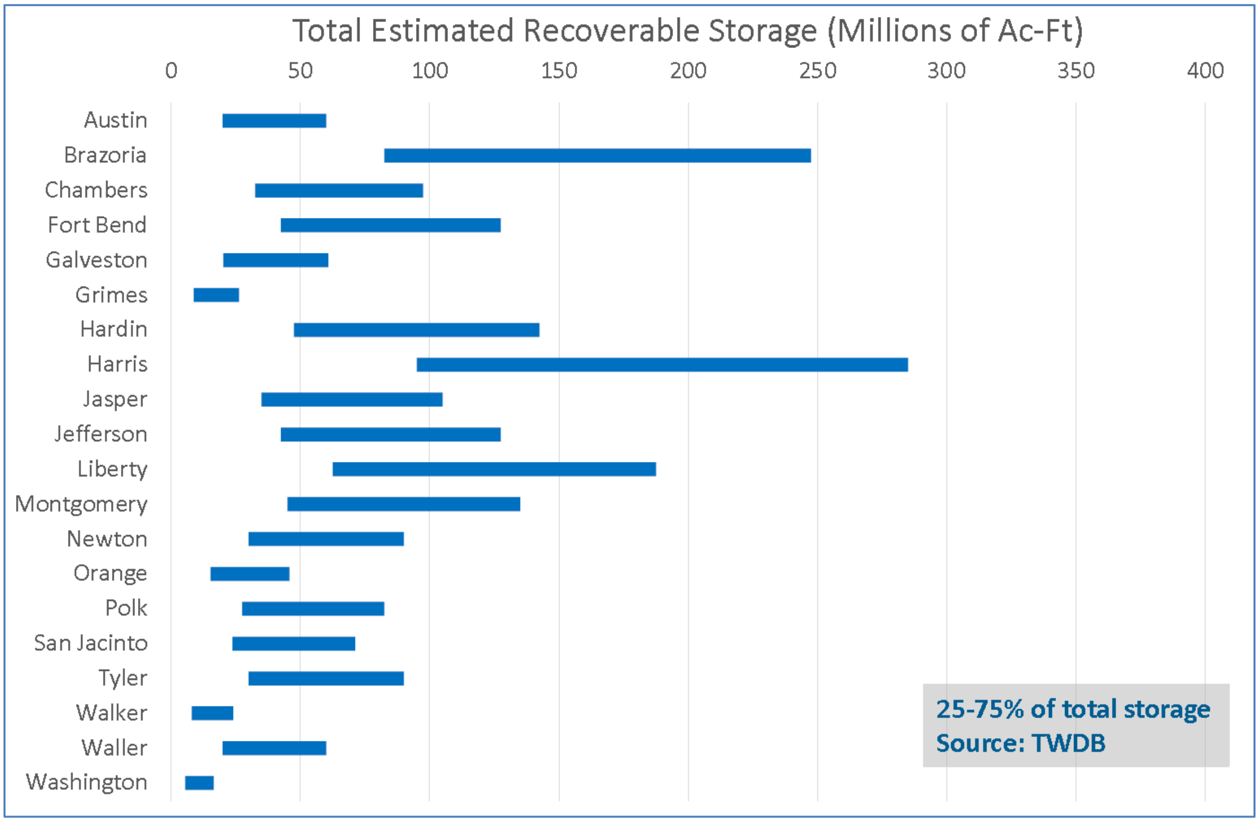

Figure 6-9. Comparison of total estimated recoverable storage in counties of Groundwater Management Area 14 (from Groundwater Management Area 14, 2016; Appendix J).

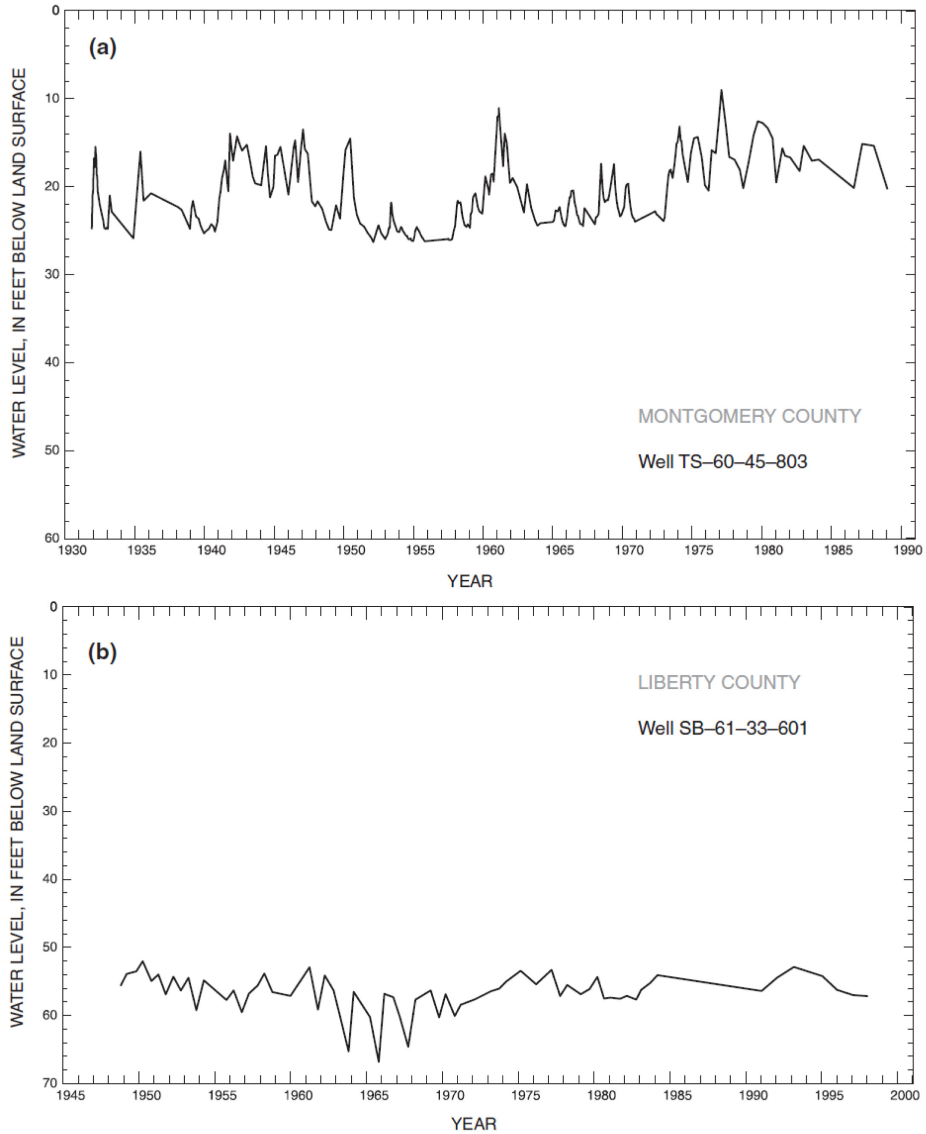

Figure 6-10. Hydrographs for outcrop area wells, showing relatively stable water-table elevations (Kasmarek and Robinson, 2004).

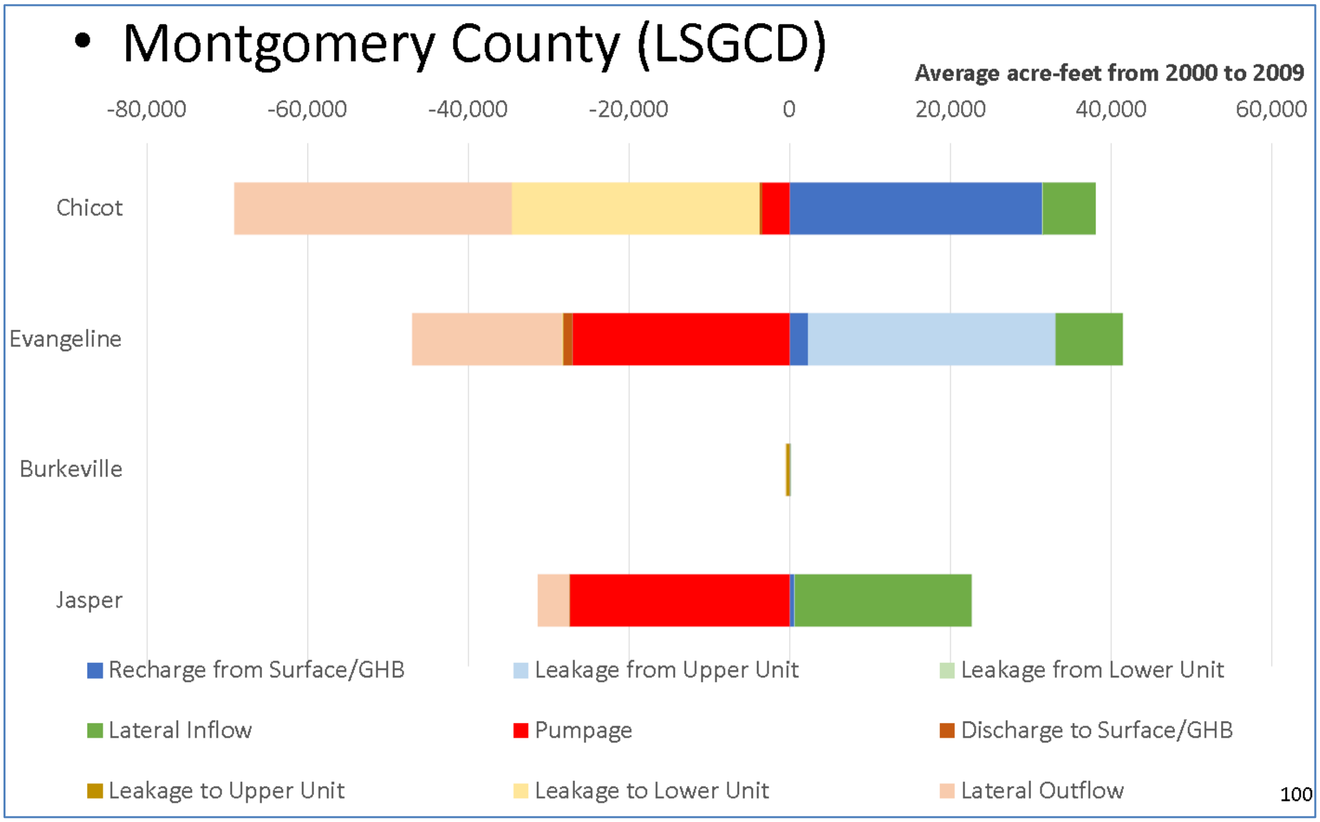

Figure 6-11. Modeled water budget for Montgomery County (from Groundwater Management Area 14, 2016; Appendix J).

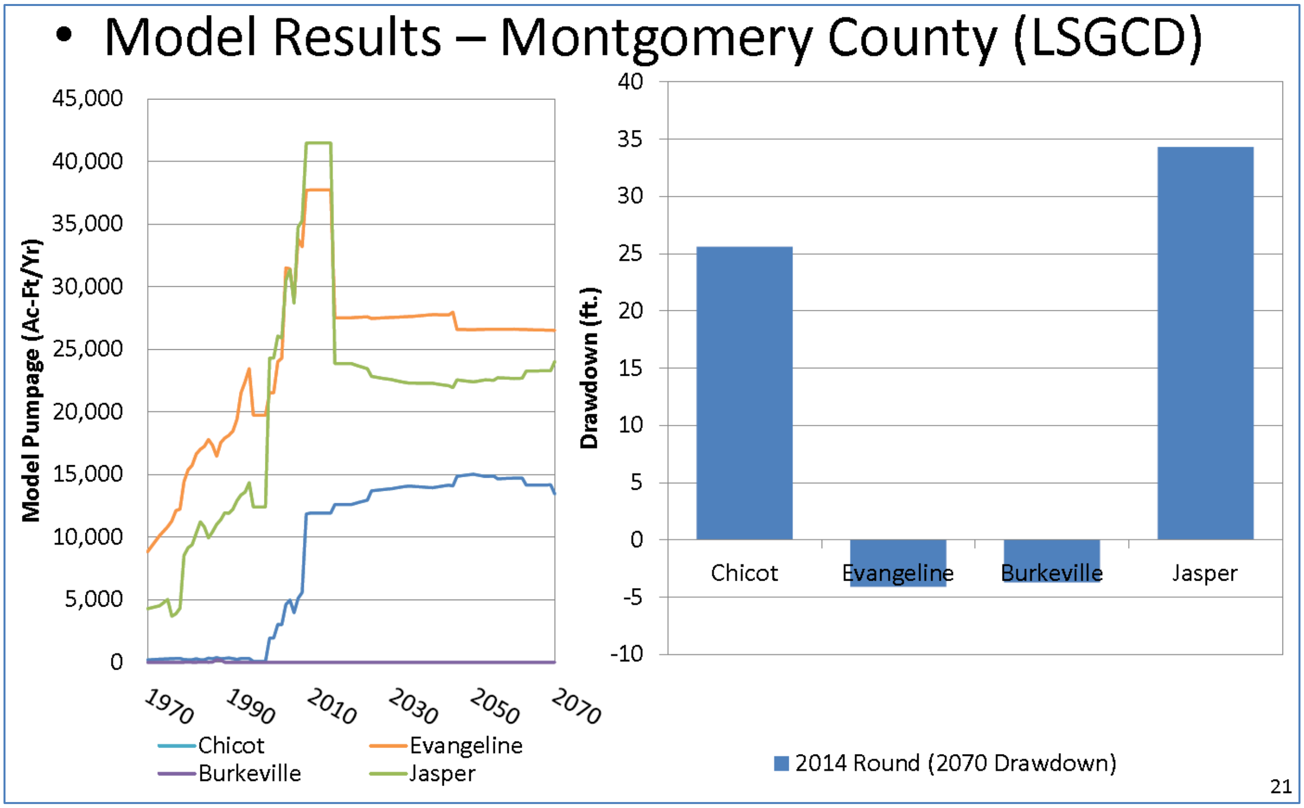

Figure 6-12. Modeled pumping rates for Montgomery County from 1970 through 2070 in the Chicot, Evangeline, and Jasper aquifers (from Mullican and Associates, 2015).

Reach	Water Quality Segment	SW/GW Interaction	Aquifer	Probability/ Comment
San Jacinto River above Lake Houston: East Fork, Peach Creek, Caney Creek	1003, 1011, 1010	Yes, gaining	Gulf Coast aquifer: the entire watershed is over the aquifer.	Medium: due to subhumid region, the Gulf Coast aquifer would reject recharge in this basin.
San Jacinto River above Lake Houston: West Fork, Spring Creek, Cypress Creek	1002, 1004, 1012, 1015, 1008, 1009	Yes, gaining or losing	Gulf Coast aquifer: the entire watershed is over the aquifer. Lake Conroe and Houston may recharge groundwater and then show up downstream as baseflow.	Medium: due to subhumid region, the Gulf Coast aquifer would reject recharge in this basin.
San Jacinto River below Lake Houston and above tide	1001	Yes, gaining or potentially losing	Gulf Coast aquifer: the entire watershed is over the aquifer. Lake Conroe and Houston may recharge groundwater and then show up downstream as baseflow.	Medium: due to subhumid region, the Gulf Coast aquifer would reject recharge in this basin. However, regional groundwater withdrawal would induce stream loss to aquifer.
Buffalo Bayou	1006, 1007	Yes, gaining	Gulf Coast aquifer: the entire watershed is over the aquifer. Lake Conroe and Houston may recharge groundwater and then show up downstream as baseflow.	Medium: due to subhumid region, the Gulf Coast aquifer would reject recharge in this basin.

Figure 6-13. Surface water-groundwater interactions in the San Jacinto river basin (from Parsons, 1999).

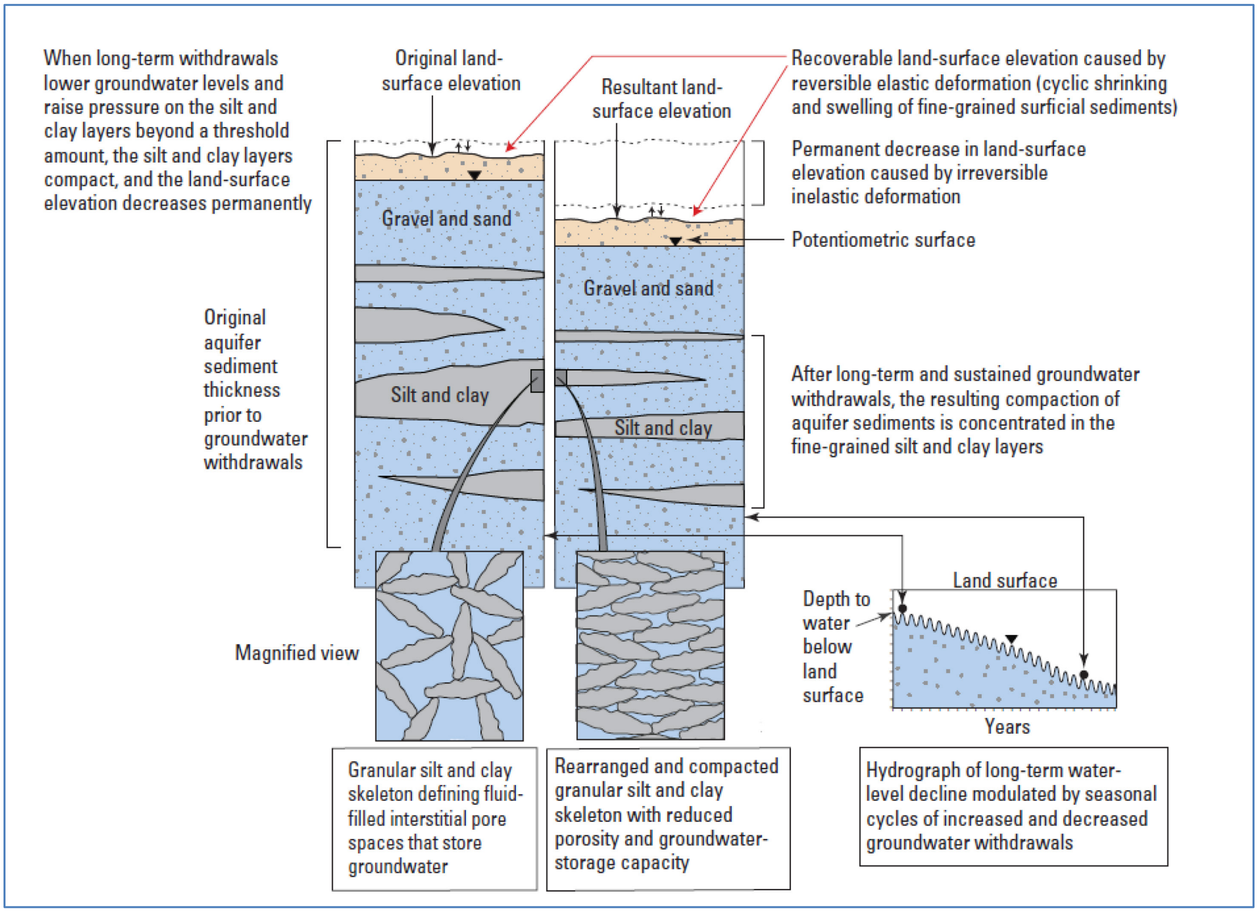

Figure 6-14. Mechanism of subsidence (from Kasmarek and others, 2015).

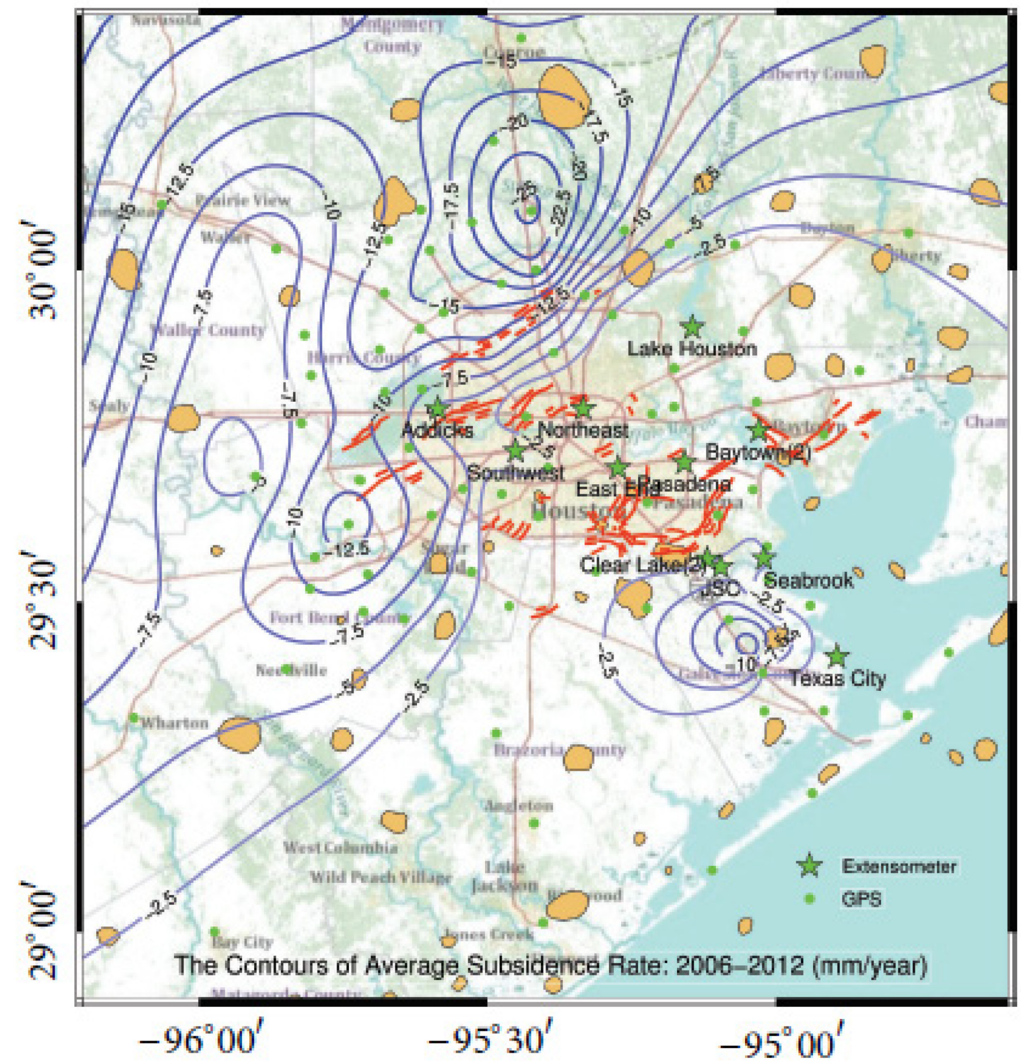

Figure 6-15. Map showing contours of the average subsidence rate, in millimeters per year, from 2006 to 2012. Red lines represent mapped faults and tan areas represent the locations of salt domes (from Yu and others, 2014).

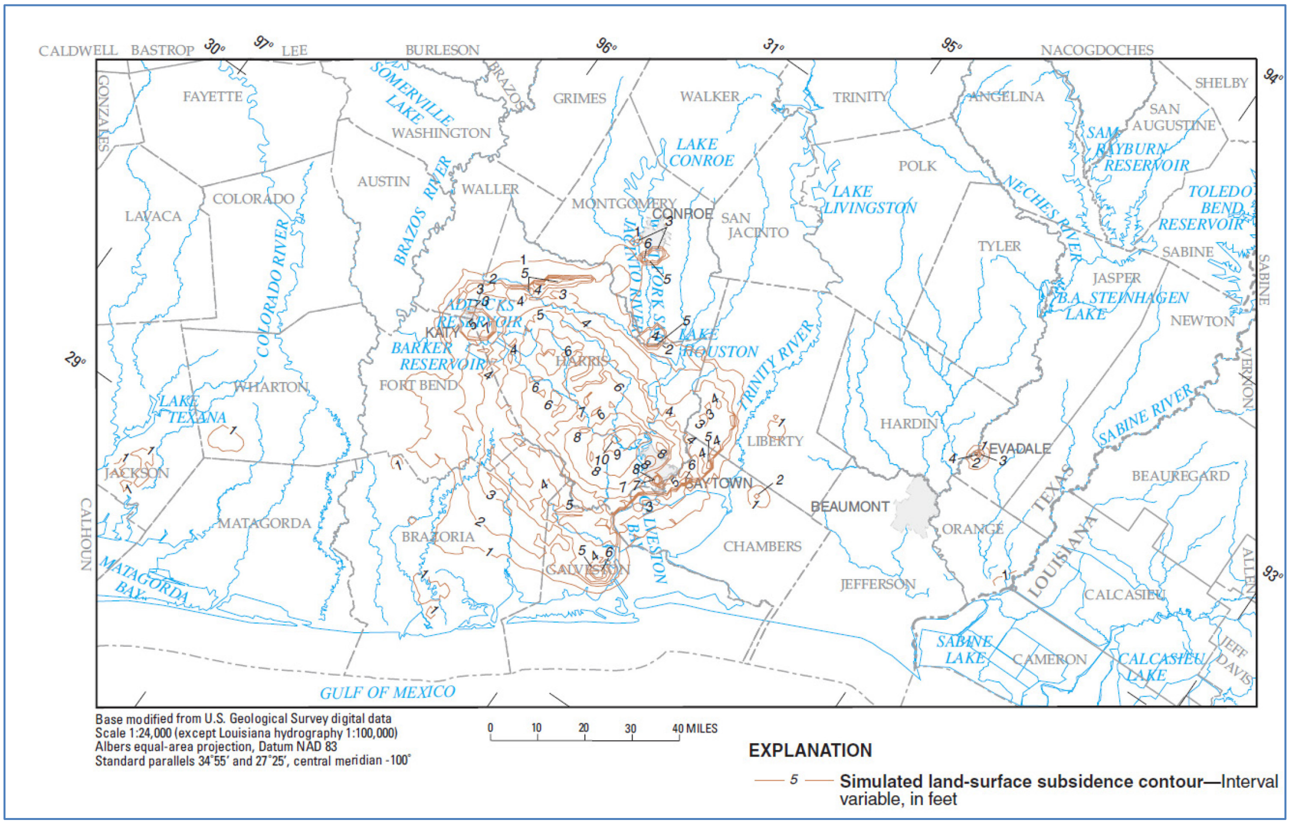

Figure 6-16. Simulated 2010 land-surface subsidence in the northern portion of the Gulf Coast Aquifer System groundwater availability model area (from Kasmarek and others, 2005).

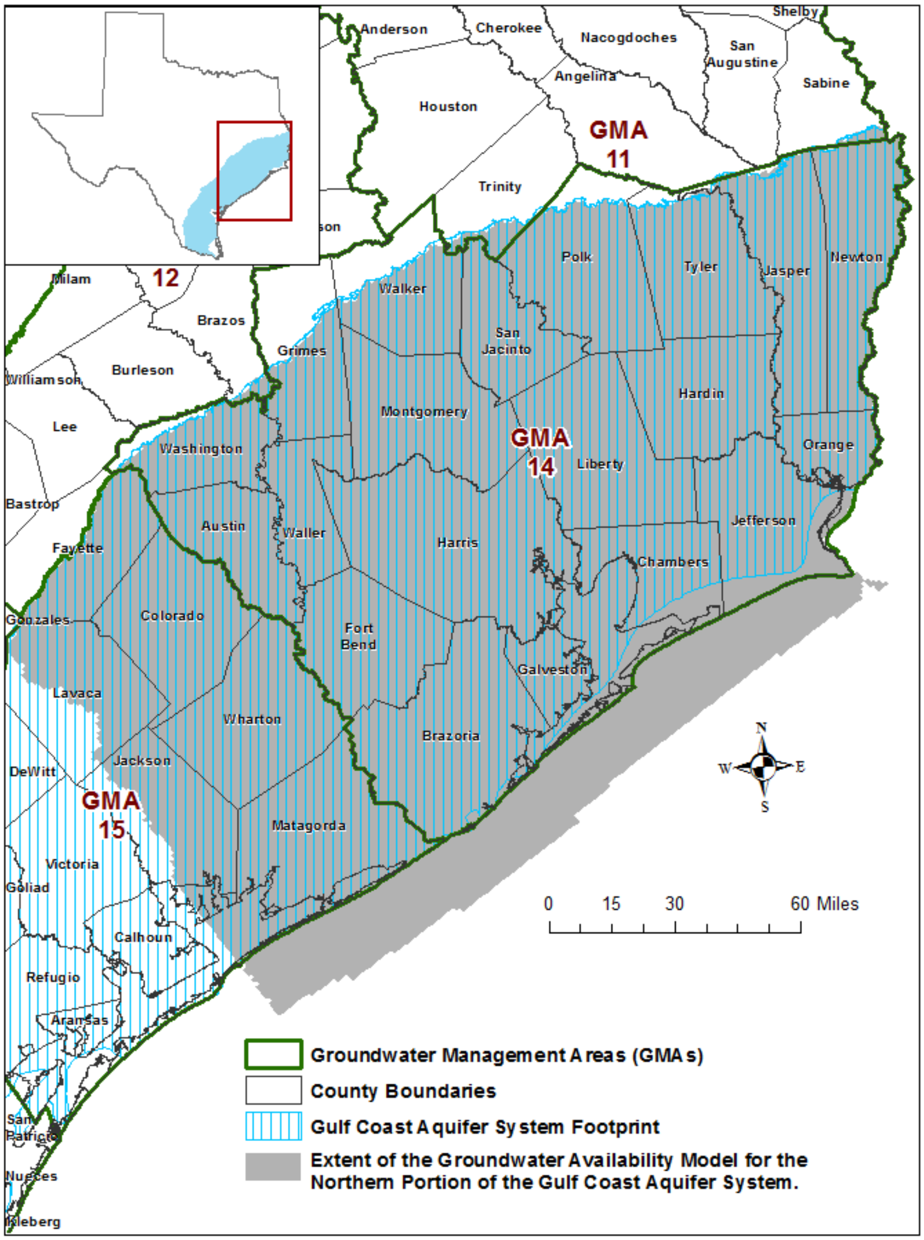

Figure 7-1 Area covered by the groundwater availability model for the northern part of the Gulf Coast Aquifer System (from Wade, 2016).

Geologic (stratigraphic) units			Hydrogeologic units	Model layer
System	Series	Formation	Aquifers and confining units	
Quaternary	Holocene	Alluvium	Chicot aquifer	1
	Pleistocene	Beaumont Formation		
		Montgomery Formation		
		Bentley Formation		
		Willis Formation		
Tertiary	Pliocene	Goliad Sand	Evangeline aquifer	2
	Miocene	Fleming Formation	Burkeville confining unit	3
		Oakville Sandstone	Jasper aquifer	4
		Catahoula Sandstone		
		Anahuac Formation[1]	Catahoula confining system	
		Frio Formation[1]		

[1]Present only in subsurface.

Figure 7-2 Hydrostratigraphy and layers in the groundwater availability model for the northern part of the Gulf Coast Aquifer System (from Kasmarek, 2012).

Tables

Table 5-1: Summary of desired future conditions adopted by the District in 2010.

Aquifer	Baseline year	Desired future condition drawdown (feet)	Comments
Chicot	2008	3	After 8 years
	2016	6	After 44 years
Evangeline	2008	13	After 8 years
	2016	25	After 44 years
Burkeville Confining Unit	2008	10	After 8 years
	2016	23	After 44 years
Jasper	2008	61	After 8 years
	2016	-38	After 44 years

Table 5-2: Summary of desired future conditions adopted by the District in 2016.

Aquifer	Baseline year	Desired future condition drawdown[1] (feet)	Comments
Chicot	2009	26	After 61 years
Evangeline	2009	-4	After 61 years
Burkeville Confining Unit	2009	-4	After 61 years
Jasper	2009	34	After 61 years

[1]Not to exceed values.

Table 5-3: Comparison of the 2010 and 2016 adopted desired future conditions and modeled available groundwater values for the District.

	2010 adopted desired future condition		2016 adopted desired future condition	
Aquifer	**2060 Drawdown (feet) from baseline year**	**Modeled available groundwater (acre-feet per year)**	**2070 Drawdown (feet) from baseline year**	**Modeled available groundwater (acre-feet per year)**
Chicot	9	1,722	26	14,175
Evangeline	38	38,293	-4	26,529
Burkeville Confining Unit	33	0	-4	0
Jasper	23	21,614	34	23,301
Total modeled available groundwater	-	61,629	-	64,005

Table 6-1: Groundwater use in 2015 reported to the District

Groundwater use	Volume, gallons	Volume, acre-feet	Percent of total
Commercial	65,836,325	202	0.3
Industrial	438,546,351	1,346	1.9
Irrigation	781,359,117	2,398	3.4
Irrigation (agriculture)	127,912,950	392	0.6
Public supply	467,832,045	1,438	2.0
Public water supply	20,154,913,252	61,853	86.8
AWS-CRAF[1]	1,182,948,000	3,630	5.1
Total[2]	**23,219,348,040**	**71,257**	

1. AWS-CRAF: Alternative Water Supply - Catahoula Restricted Aquifer Formation
2. Data received as of March 23, 2016. The reported pumping for 2015 is incomplete due to incomplete reporting by a small number of permittees

Table 6-2. Annual groundwater pumpage data from the Groundwater Management Area 14 explanatory report and TWDB historical groundwater pumpage estimates

Year	Montgomery County groundwater pumpage from explanatory report, acre-feet	Montgomery County groundwater pumpage from TWDB database, acre-feet*
2000	55,699	55,853
2001	52,494	52,497
2002	55,514	55,517
2003	54,925	54,928
2004	46,006	54,138
2005	57,259	66,244
2006	67,260	67,122
2007	63,414	63,422
2008	70,328	70,414
2009	73,520	73,803
2010	81,643	80,750
2011	90,247	103,700
2012		88,076
2013		83,784
2014		76,045

*From http://www.twdb.texas.gov/waterplanning/waterusesurvey/historical-pumpage.asp

Table 6-3. Average groundwater pumping by use and aquifer for 2007–2011 in the Lone Star Groundwater Conservation District (values in acre-feet per year)

Aquifer	Irrigation	Livestock	Municipal	Manufacturing	Mining	Power
Gulf Coast Aquifer	1,356	552	54,541	576	2	376
Yegua-Jackson Aquifer	-	-	-	-	-	-
Brazos River Alluvium Aquifer	-	-	-	-	-	-
Carrizo-Wilcox Aquifer	-	-	-	-	-	-
Queen City Aquifer	-	-	-	-	-	-
Sparta Aquifer	-	-	-	-	-	-
Other/unknown aquifer	-	-	18,027	3	309	-
Total	**1,356**	**552**	**72,668**	**579**	**311**	**376**

Source: Explanatory Report, p. 40

Table 6-4. Total estimated recoverable storage (in acre-feet) separated into unconfined and confined components for the Gulf Coast Aquifer System in the Lone Star Groundwater Conservation District

Unconfined storage	Confined storage	Total storage	25% of total storage	75% of total storage
177,162,460	459,467	180,000,000	45,000,000	135,000,000

Note: The total estimated recoverable storage values by groundwater conservation district and county for an aquifer may not be the same because the numbers have been rounded to two significant digits.

Table 6-5. Water budget model output for Montgomery County

Montgomery County				
Inflow	**Chicot**	**Evangeline**	**Burkeville**	**Jasper**
Recharge/Stream Loss (GHB)	31,407	2,251	1	548
Storage	31,140	5,783	413	8,690
Leakage From Upper Unit	—	30,813	105	64
Leakage From Lower Unit	98	—	—	—
Lateral Flow From Grimes	26	543	3	3,379
Lateral Flow From Harris	2,694	3,595	2	3,889
Lateral Flow From Liberty	2,475	1,169	0	806
Lateral Flow From Waller	987	1,027	1	1,166
Lateral Flow From San Jacinto	366	1,556	4	1,943
Lateral Flow From Walker	12	477	4	10,845
Total Inflow	69,207	47,213	534	31,331
Outflow	**Chicot**	**Evangeline**	**Burkeville**	**Jasper**
Wells	3,426	27,017	—	27,377
Evapotranspiration/Stream Gain (GHB)	343	1,141	0	12
Storage	92	704	60	85
Leakage To Upper Unit	—	98	470	69
Leakage To Lower Unit	30,813	105	64	—
Lateral Flow To Grimes	—	7	0	20
Lateral Flow To Harris	33,337	17,670	8	3,637
Lateral Flow To Liberty	1,009	423	0	27
Lateral Flow To San Jacinto	110	328	0	140
Lateral Flow To Waller	76	190	0	—
Lateral Flow To Walker	1	—	0	79
Total Outflow	69,207	47,683	603	31,446
Inflow - Outflow	0	-470	-69	-115
Storage Increase (+)/Decrease(-)	-31,048	-5,079	-353	-8,605

All values are average acre-feet per year from 2000 through 2009.

Source: Mullican Associates, 2015, Review of Proposed Desired Future Conditions and Statutory Criteria from TWC 36.108(d)(1)-(9), June 24, 2015, Groundwater Management Area 14

APPENDIX A

Letter from Jeff Walker, TWDB's Executive Administrator, to Kathy Turner Jones, General Manager of the Lone Star Groundwater Conservation District and Chair for Groundwater Management Area 14 Planning Group, concerning the administrative completeness of the explanatory report and other documentation submitted by the district representatives of Groundwater Management Area 14

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

July 12, 2016

Ms. Kathy Turner Jones
General Manager
Lone Star Groundwater Conservation District
655 Conroe Park North Drive
Conroe, TX 77303

Dear Ms. Jones:

The purpose of this letter is to acknowledge receipt of your submission of the desired future conditions explanatory report and other materials required by Texas Water Code §36.108(d-3) and notify you that the submitted report and materials are administratively complete in accordance with 31 Texas Administrative Code §356.33.

On May 6, 2016, the Texas Water Development Board received the explanatory report and other materials for desired future conditions adopted by groundwater conservation district representatives in Groundwater Management Area 14. Your submission included: (1) the desired future conditions explanatory report and the adopted desired future conditions for the relevant aquifers; (2) the resolution signed by district representatives voting on the adoption of the desired future conditions; (3) the postings, minutes, and voting record for the public meeting in which the desired future conditions were adopted; (4) contact information for the designated representative of the groundwater management area; and (5) the groundwater availability model files used in developing the adopted desired future conditions.

We will provide you with modeled available groundwater values for these aquifers no later than 180 days after the date of this letter in accordance with 31 Texas Administrative Code §356.35. Please contact Dr. Rima Petrossian of my staff at (512) 936-2420 or rima.petrossian@twdb.texas.gov if you have any questions.

Sincerely,

Jeff Walker
Executive Administrator

c: Larry French, P.G., Director, Groundwater Division
Rima Petrossian, Ph.D., P.G., Manager, Groundwater Technical Assistance
Matt Nelson, Director, Water Use, Projections, and Planning
Temple McKinnon, P.G., Manager, Regional Water Planning

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APPENDIX B

TWDB Memorandum Dated March 10, 2010

Briefing and discussion on (a) status of joint planning in groundwater management areas and (b) use of “geographic areas” in establishing desired future conditions

TO: Board Members

THROUGH: Robert E. Mace, Deputy Executive Administrator, Water Science and Conservation

FROM: William R. Hutchison, Director, Groundwater Resources Division
Kenneth L. Petersen, General Counsel

DATE: March 10, 2010

SUBJECT: Briefing and discussion on: (a) status of joint planning in groundwater management areas; and (b) use of "geographic areas" in establishing desired future conditions.

ACTION REQUESTED

No action requested; this is a discussion item.

BACKGROUND

Key background points are:

- Groundwater management areas are required to submit desired future conditions to the Texas Water Development Board (TWDB) by September 1, 2010.
- Once desired future conditions are submitted, Groundwater Resources Division staff develops values of managed available groundwater based on the desired future condition.
- Groundwater conservation districts are required to include the desired future condition and managed available groundwater number in their groundwater management plans and permitting.
- Regional water planning groups are required to use the managed available groundwater values in their regional water plans if they are received in a timely manner.
- Once adopted, desired future conditions can be challenged by petitioning the TWDB.
- If the Board finds that the desired future condition is reasonable, the petition process ends.
- If the Board finds that the desired future condition is not reasonable, TWDB staff issues written findings to the petitioner and the groundwater conservation districts which include a list of findings and recommended changes to the desired future condition.
- The groundwater conservation districts are then required to prepare a revised desired future condition, to hold a public hearing, and to submit the revised future condition to the Board.
- TWDB will then provide public notice of the revised desired future condition and may provide a public response to the districts' revised conditions, at which point the petition process is concluded.

<u>KEY ISSUES</u>

(a) Status of joint planning in groundwater management areas

The status of desired future conditions, managed available groundwater determinations, and active petitions is shown in the attachment. Progress during the first two months of 2010 includes:

- The groundwater conservation districts in Groundwater Management Area 11 adopted a set of preliminary desired future conditions that will generally result in managed available groundwater values that are about the same as the 2007 State Water Plan groundwater availability estimates. It is expected that formal adoption will occur at their April meeting after a series of public meetings being organized by individual groundwater conservation districts
- The groundwater conservation districts in Groundwater Management Area 12 adopted a set of preliminary desired future conditions. It is expected that formal adoption will occur at their April meeting.

(b) Use of "geographic areas" in establishing desired future conditions

Section 36.108(d) provides that groundwater conservation districts "shall consider uses or conditions of an aquifer within the management area that differ substantially from one geographic area to another" when establishing desired future conditions. However, the law does not define "geographic area" and there is no guidance to the districts either on how to delineate a geographic area or on how to measure "substantial" differences between geographic areas in either uses or conditions. Under Section 36.108(d)(2), districts may establish different desired future conditions within a management area for "each geographic area overlying an aquifer in whole or in part ... within the boundaries of the management area."

The question has been presented whether groundwater conservation districts within a groundwater management area (GMA) may delineate different "geographic areas" within the GMA by use of county (or other political subdivision) boundaries. Staff believes this approach is legally defensible provided the districts are using the political subdivision boundaries to locate discernible and substantial differences in uses or conditions within the GMA and not for any other purposes. It should be emphasized that employing geographic areas that are not based on clear and substantial differences in uses or aquifer conditions is not supportable, regardless of how those geographic areas are drawn.

As noted, there is no definition of "geographic" or "geographic area" in Chapter 36, Water Code, nor are there any such definitions in the Code Construction Act which is generally applicable to statutory schemes. Webster's Third New International Dictionary (Unabridged, 1993) recognizes "political geography" as one form of geography (in addition to "mathematical geography," "physical geography," "economic geography," "commercial geography" and "bio-geography"). The argument that the omission of "political subdivision boundaries" from Section 36.108(d) is not persuasive, as long as the groundwater conservation districts do not appear to be using county or other political subdivision lines to gerrymander DFCs for purposes other than accommodating discernible, substantial differences in uses or aquifer conditions within the GMA. (Known as the doctrine of expressio unius est exclusion alterius, the courts have stated that this approach to statutory construction is simply an aid to determine legislative intent and that it should not be mechanically applied. Mid-Century Insurance Co. of Texas v. Kidd, 1999 WL 450908 (Tex. 1999).

Attachment

APPENDIX C

Letter from Kevin Patteson, TWDB's Executive Administrator, to Mike Turco, General Manager of the Harris-Galveston Subsidence District, approving the Houston Area Groundwater Model as the groundwater availability model for the northern segment of the Gulf Coast Aquifer System

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

February 18, 2014

Mr. Mike Turco
General Manager
Harris Galveston Subsidence District
1660 West Bay Area Blvd.
Friendswood, TX 77546

Re: Approval of Houston Area Groundwater Model as the Official Groundwater Availability Model for the Northern Segment of the Gulf Coast Aquifer System

Dear Mr. Turco,

I am approving the request, transmitted in a letter dated April 15, 2013, from Mr. Ron Neighbors of the Harris-Galveston Subsidence District to Mr. Larry French of the Texas Water Development Board (Attachment 1), to designate the Houston Area Groundwater Model as the official groundwater availability model of the Northern Segment of the Gulf Coast Aquifer System. This action is pursuant to the provisions of Texas Water Code Section 16.012 (l) and is based on our technical evaluation of the Houston Area Groundwater Model compared to the existing groundwater availability model (Northern Gulf Coast Groundwater Availability Model). My staff has conducted this evaluation considering the technical requirements of joint planning and establishment of desired future conditions for the aquifers of Groundwater Management Area 14. I am also including documentation of the technical analysis (Attachment 2), as well as the comments of various groundwater stakeholders (Attachment 3) and TWDB responses to the comments (Attachment 4).

I appreciate the thoughtful and rigorous reviews that commenters have performed with respect to the Houston Area Groundwater Model. My staff agrees with a number of the technical issues that have been raised but note that most of these issues are also valid with respect to the existing groundwater availability model for the northern segment of the Gulf Coast Aquifer System. My staff will retain these technical comments and consider them when the TWDB performs future upgrades or improvements on the model.

By copy of this letter I am also informing the groundwater conservation districts in Groundwater Management Area 14 and the regional water planning groups of this action.

Please contact Mr. Larry French (512-463-5067) of my staff if you have any questions.

Sincerely,

Kevin Patteson
Executive Administrator

Attachments

C w/att: Robert Mace, Ph.D., P.G.
Larry French, P.G.
Cindy Ridgeway, P.G.
Kathy Turner Jones, Lone Star Groundwater Conservation District
Zach Holland, Bluebonnet Groundwater Conservation District
John Pyburn, Brazoria County Groundwater Conservation District
Bill Jacobs, Lower Trinity Groundwater Conservation District
John Martin, Southeast Texas Groundwater Conservation District
Mark Evans, North Harris County Regional Water Authority (Region H)
Kelley Holcomb, Angelina & Neches River Authority (Region I)
Wayne Wilson, Wilson Cattle Company (Region G)
John E. Burke, John Burke & Associates (Region K)